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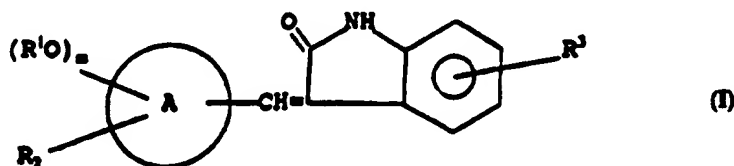
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(54) Title: HYDROSOLUBLE 3-ARYLIDENE-2-OXINDOLE DERIVATIVES AS TYROSINE KINASE INHIBITORS



(57) Abstract

Novel hydrosoluble 3-arylidene-2-oxindole derivatives, having tyrosine kinase inhibitor activity, encompassed by general formula (I), wherein m is zero, 1 or 2; A is a bicyclic ring chosen from tetralin, naphthalene, quinoline and indole; R<sup>1</sup> is hydrogen, C<sub>1</sub>-C<sub>6</sub> alkyl or C<sub>2</sub>-C<sub>6</sub> alkenoyl; one of R<sup>2</sup> and R<sup>3</sup> independently is hydrogen and the other is a substituent selected from: a C<sub>1</sub>-C<sub>6</sub> alkyl group substituted by 1, 2 or 3 hydroxy groups; -SO<sub>2</sub>R<sup>4</sup> in which R<sup>4</sup> is hydrogen or C<sub>1</sub>-C<sub>6</sub> alkyl unsubstituted or substituted by 1, 2 or 3 hydroxy groups; -SO<sub>2</sub>NHR<sup>5</sup> in which R<sup>5</sup> is as R<sup>4</sup> defined above or a -(CH<sub>2</sub>)<sub>n</sub>-N(C<sub>1</sub>-C<sub>6</sub> alkyl)<sub>2</sub> group in which n is 2 or 3; -COOR<sup>6</sup> in which R<sup>6</sup> is C<sub>1</sub>-C<sub>6</sub> alkyl unsubstituted or substituted by phenyl or by 1, 2 or 3 hydroxy groups or phenyl; -CONHR<sup>7</sup> in which R<sup>7</sup> is hydrogen, phenyl or C<sub>1</sub>-C<sub>6</sub> alkyl substituted by 1, 2 or 3 hydroxy groups or by phenyl; -NHSO<sub>2</sub>R<sup>8</sup> in which R<sup>8</sup> is C<sub>1</sub>-C<sub>6</sub> alkyl or phenyl unsubstituted or substituted by halogen or by C<sub>1</sub>-C<sub>6</sub> alkyl; -N(R<sup>9</sup>)<sub>2</sub>, -NHR<sup>9</sup> or -OR<sup>9</sup> wherein R<sup>9</sup> is C<sub>2</sub>-C<sub>6</sub> alkyl substituted by 1, 2 or 3 hydroxy groups; -NHCOR<sup>10</sup>, -OOCR<sup>10</sup> or -CH<sub>2</sub>OOCR<sup>10</sup> in which R<sup>10</sup> is C<sub>1</sub>-C<sub>6</sub> alkyl substituted by 1, 2 or 3 hydroxy groups; -NHCONH<sub>2</sub>; -NH-C(NH<sub>2</sub>)-NH; -C(NH<sub>2</sub>)-NH; -CH<sub>2</sub>NHC(NH<sub>2</sub>)-NH; -CH<sub>2</sub>NH<sub>2</sub>; -OPO(OH)<sub>2</sub>; -CH<sub>2</sub>OPO(OH)<sub>2</sub>; -PO(OH)<sub>2</sub>; or (a), (b), (c), or (d) group, wherein p is 1, 2 or 3 and Z is -CH<sub>2</sub>-, -O- or (e), in which R<sup>11</sup> is hydrogen or is as R<sup>9</sup> defined above; and the pharmaceutically acceptable salts thereof, are disclosed.

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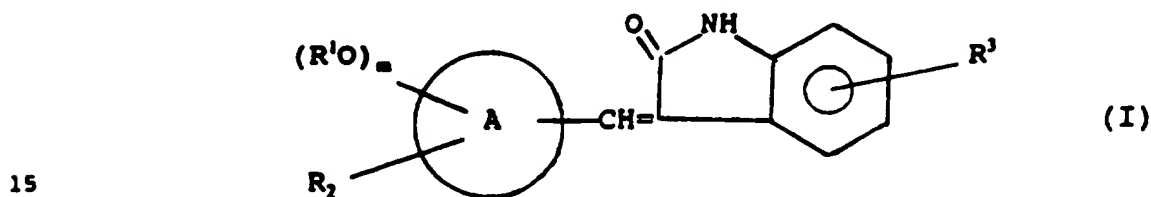
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-1-

**HYDROSOLUBLE 3-ARYLIDENE-2-OXINDOLE DERIVATIVES AS**  
**TYROSINE KINASE INHIBITORS**

The present invention relates to new hydrosoluble 3-aryl-  
 5 idene-2-oxindole derivatives, to a process for their  
 preparation, to pharmaceutical compositions containing  
 them and to their use as therapeutic agents, in  
 particular as tyrosine kinase inhibitors.

The present invention provides novel hydrosoluble 3-  
 10 arylidene-2-oxindole derivatives having the following  
 general formula (I)



wherein

m is zero, 1 or 2;

A is a bicyclic ring chosen from tetralin, naphthalene,  
 quinoline and indole;

20 R<sup>1</sup> is hydrogen, C<sub>1</sub>-C<sub>6</sub> alkyl or C<sub>1</sub>-C<sub>6</sub> alkanoyl;

one of R<sup>2</sup> and R<sup>3</sup> independently is hydrogen and the other  
 is a substituent selected from:

a C<sub>1</sub>-C<sub>6</sub> alkyl group substituted by 1, 2 or 3 hydroxy  
 groups;

25 -SO<sub>2</sub>R<sup>4</sup> in which R<sup>4</sup> is hydrogen or C<sub>1</sub>-C<sub>6</sub> alkyl unsubstituted

-2-

or substituted by 1, 2 or 3 hydroxy groups;

$-\text{SO}_2\text{NHR}^5$  in which  $\text{R}^5$  is as  $\text{R}^4$  defined above or a  $-(\text{CH}_2)_n-$

$\text{N}(\text{C}_1-\text{C}_6 \text{ alkyl})_2$  group in which  $n$  is 2 or 3;

$-\text{COOR}^6$  in which  $\text{R}^6$  is  $\text{C}_1-\text{C}_6$  alkyl unsubstituted or

5 substituted by phenyl or by 1, 2 or 3 hydroxy groups or phenyl;

$-\text{CONHR}^7$  in which  $\text{R}^7$  is hydrogen, phenyl or  $\text{C}_1-\text{C}_6$  alkyl substituted by 1, 2 or 3 hydroxy groups or by phenyl;

$-\text{NHSO}_2\text{R}^8$  in which  $\text{R}^8$  is  $\text{C}_1-\text{C}_6$  alkyl or phenyl unsubstituted





10 or substituted by halogen or by  $\text{C}_1-\text{C}_6$  alkyl;

$-\text{N}(\text{R}^9)_2$ ,  $-\text{NHR}^9$  or  $-\text{OR}^9$  wherein  $\text{R}^9$  is  $\text{C}_2-\text{C}_6$  alkyl substituted by 1, 2 or 3 hydroxy groups;

$-\text{NHCOR}^{10}$ ,  $-\text{OOCR}^{10}$  or  $-\text{CH}_2\text{OOCR}^{10}$  in which  $\text{R}^{10}$  is  $\text{C}_1-\text{C}_6$  alkyl substituted by 1, 2 or 3 hydroxy groups;

15  $-\text{NHCONH}_2$ ;  $-\text{NH}-\text{C}(\text{NH}_2)=\text{NH}$ ;  $-\text{C}(\text{NH}_2)=\text{NH}$ ;  $-\text{CH}_2\text{NHC}(\text{NH}_2)=\text{NH}$ ;

$-\text{CH}_2\text{NH}_2$ ;  $-\text{OPO}(\text{OH})_2$ ;  $-\text{CH}_2\text{OPO}(\text{OH})_2$ ;  $-\text{PO}(\text{OH})_2$ ; or a

$-\text{CH}_2-\text{N}$    $\text{Z}$ ,  $-\text{SO}_2-\text{N}$    $\text{Z}$ ,  $-\text{CON}$    $\text{Z}$  or  $-\text{NHCO}(\text{CH}_2)_p-\text{N}$    $\text{Z}$  group,

wherein  $p$  is 1, 2 or 3 and  $\text{Z}$  is  $-\text{CH}_2-$ ,  $-\text{O}-$  or  $>\text{N}-\text{R}^{11}$  in

20 which  $\text{R}^{11}$  is hydrogen or is as  $\text{R}^9$  defined above; and the pharmaceutically acceptable salts thereof.

The substituents  $\text{R}^{10}$  and  $\text{R}^2$  may be independently on either of the ring moieties whereas the  $\text{R}^3$  substituent is only linked to the benzene moiety.

25 The invention includes within its scope all the possible isomers, stereoisomers, in particular *Z*- and *E*-isomers and their mixtures, and the metabolites and the metabolic precursors or bio-precursors (otherwise known as pro-

-3-

drugs) of the compound of formula (I).

The oxindolylidene substituent is preferably linked to position 1 or 2 when A is tetralin or naphthalene, to position 4 or 5 when A is quinoline and to position 3 when A is indole.

The R<sup>3</sup> substituent is preferably linked to position 5 in the oxindole ring.

The R<sup>2</sup> substituent with reference to the oxindolylidene substituent is preferably linked to the same ring moiety when A is tetralin, whereas it is preferably linked to the other ring moiety when Ar is naphthalene, quinoline or indole.

The OR<sup>1</sup> substituent is preferably located on the same benzene moiety when A is tetralin, quinoline or indole whereas it may be located on either benzene moieties when A is naphthalene.

m is preferably zero when R<sup>2</sup> is not hydrogen.

Of course only one of the substituents R<sup>1</sup>O and R<sup>2</sup> can be linked to the same ring position.

An alkyl group or an alkyl moiety in an alkanoyl group may be branched or straight alkyl chain.

A C<sub>1</sub>-C<sub>6</sub> alkyl group is preferably a C<sub>1</sub>-C<sub>4</sub> alkyl group, e.g. methyl, ethyl, propyl, isopropyl, butyl, sec-butyl or tert-butyl, in particular methyl or ethyl.

A C<sub>2</sub>-C<sub>6</sub> alkyl group is preferably a C<sub>2</sub>-C<sub>4</sub> alkyl group in particular ethyl.

A C<sub>1</sub>-C<sub>6</sub> alkyl group substituted by 1 to 3 hydroxy groups is, for instance, a C<sub>1</sub>-C<sub>4</sub> alkyl group substituted by 1 or

-4-

2 hydroxy groups, typically a  $-\text{CH}_2\text{OH}$ ,  $-\text{CHOHCH}_2\text{OH}$  or  $-\text{CH}_2(\text{CHOH})_q\text{CH}_2\text{OH}$  group in which  $q$  is zero or 1.

A halogen atom is for example chloro, bromo or iodo, in particular chloro.

5 A  $\text{C}_1\text{-C}_6$  alkyl group substituted by phenyl is typically benzyl or phenylethyl.

A  $\text{C}_2\text{-C}_6$  alkanoyl group is preferably a  $\text{C}_2\text{-C}_3$  alkanoyl group, in particular acetyl or propionyl.

10 The term tetralin is meant to refer to 5,6,7,8-tetrahydronaphthalene.


Pharmaceutically acceptable salts of the compounds of the invention include acid addition salts with inorganic, e.g. nitric, hydrochloric, hydrobromic, sulphuric, perchloric and phosphoric acids or organic, e.g. acetic, 15 trifluoroacetic, propionic, glycolic, lactic, oxalic, malonic, malic, maleic, tartaric, citric, benzoic, cinnamic, mandelic and salicylic acids, and salts with inorganic, e.g. alkali metal, especially sodium or potassium bases or alkaline-earth metal, especially 20 calcium or magnesium bases, or with organic bases, e.g. acyclic or cyclic amines, preferably triethylamine or piperidine.

As stated above, the present invention also includes within its scope pharmaceutically acceptable bio- 25 precursors (otherwise known as pro-drugs) of the compounds of formula (I), i.e. compounds which have a different formula to formula (I) above but which, nevertheless, upon administration to a human being are

-5-

converted directly or indirectly in vivo into a compound of formula (I).

Preferred compounds of the invention are the compounds of formula (I) wherein

- 5 A and m are as defined above;  
 R<sup>1</sup> is hydrogen or C<sub>1</sub>-C<sub>4</sub> alkyl;  
 one of R<sup>2</sup> and R<sup>3</sup> independently is hydrogen and the other is a substituent selected from -SO<sub>3</sub>H; -SO<sub>2</sub>NH<sub>2</sub>; COOR<sup>6</sup> wherein R<sup>6</sup> is C<sub>1</sub>-C<sub>4</sub> alkyl or benzyl, -CONHR<sup>7</sup> wherein R<sup>7</sup> is  
 10 phenyl or benzyl; -N(CH<sub>2</sub>CH<sub>2</sub>OH)<sub>2</sub>; -NHCH<sub>2</sub>CHOHCH<sub>2</sub>OH; -NHCONH<sub>2</sub>; -NHC(NH<sub>2</sub>)=NH; -NHCOCHOHCH<sub>2</sub>OH; -NHCOCH<sub>2</sub>CH<sub>2</sub>-;  
 -NHSO<sub>2</sub>C<sub>1</sub>-C<sub>4</sub> alkyl; -OCH<sub>2</sub>CHOHCH<sub>2</sub>OH; -OOCCH<sub>2</sub>OH; -CH<sub>2</sub>NH<sub>2</sub>; -CH<sub>2</sub>OH; -C(NH<sub>2</sub>)=NH and -OPO(OH)<sub>2</sub>; and the pharmaceutically acceptable salts thereof.
- 15 Examples of specific compounds of the invention are the following compounds, which, when appropriate, may be either Z- or E-diastereomers or Z,E-mixtures of said diastereomers:
- 5-sulfo-3-[1,4-dihydroxytetral-2-ylmethylene]-2-oxindole;  
 20 5-sulfamoyl-3-[1,4-dihydroxytetral-2-ylmethylene]-2-oxindole;  
 5-sulfo-3-[1-hydroxytetral-2-ylmethylene]-2-oxindole;  
 5-sulfamoyl-3-[1-hydroxytetral-2-ylmethylene]-2-oxindole;  
 5-sulfo-3-[3-hydroxytetral-2-ylmethylene]-2-oxindole;  
 25 5-sulfamoyl-3-[3-hydroxytetral-2-ylmethylene]-2-oxindole;  
 5-sulfo-3-[4-hydroxytetral-1-ylmethylene]-2-oxindole;  
 5-sulfamoyl-3-[4-hydroxytetral-1-ylmethylene]-2-oxindole;  
 5-carbomethoxy-3-[1,4-dihydroxytetral-2-ylmethylene]-2-

-6-

- oxindol ;
- 5-carbomethoxy-3-[3-hydroxytetral-2-ylmethylene]-2-oxindole;
- 5-diethanolamino-3-(1,4-dihydroxytetral-2-ylmethylen )-2-oxindole;
- 5-(2,3-dihydroxypropylamino)-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;
- 5-ureido-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;
- 10 5-guanidino-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;
- 5-glyceroylamido-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;
- 5-(3-piperidinopropionylamino)-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;
- 15 5-mesylamino-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;
- 5-glycoloyloxy-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;
- 20 5-(2,3-dihydroxypropoxy)-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;
- 5-aminomethyl-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;
- 5-amidino-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;
- 25 5-hydroxymethyl-3-(1,4-dihydroxytetral-2-ylmethyl n )-2-oxindole;
- 5-phosphonooxy-3-(1,4-dihydroxytetral-2-ylmethylene)-2-



-7-

- oxindole;
- 5-sulfo-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-sulfamoyl-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-carbomethoxy-3-(quinol-4-ylmethylene)-2-oxindole;
- 5 5-diethanolamino-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-(2,3-dihydroxypropylamino)-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-ureido-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-guanidino-3-(quinol-4-ylmethylene)-2-oxindole;
- 10 5-glyceroylamido-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-(3-piperidinopropionylamino)-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-mesylamino-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-glycoloyloxy-3-(quinol-4-ylmethylene)-2-oxindole;
- 15 5-(2,3-dihydroxypropoxy)-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-aminomethyl-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-amidino-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-hydroxymethyl-3-(quinol-4-ylmethylene)-2-oxindole;
- 20 5-phosphonoxy-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-sulfo-3-(indol-3-ylmethylene)-2-oxindole;
- 5-sulfamoyl-3-(indol-3-ylmethylene)-2-oxindole;
- 5-carbomethoxy-3-(indol-3-ylmethylene)-2-oxindole;
- 5-diethanolamino-3-(indol-3-ylmethylene)-2-oxindole;
- 25 5-(2,3-dihydroxypropylamino)-3-(indol-3-ylmethyl ne)-2-oxindol ;
- 5-ureido-3-(indol-3-ylmethylene)-2- xindole;
- 5-guanidino-3-(indol-3-ylmethylene)-2-oxindole;

-8-

- 5-glyceroylamido-3-(indol-3-ylmethylene)-2-oxindole;  
5-(3-piperidinopropionylamino)-3-(indol-3-ylmethylene)-2-oxindole;  
5-mesylamino-3-(indol-3-ylmethylene)-2-oxindole;  
5 5-glycoloyloxy-3-(indol-3-ylmethylene)-2-oxindole;  
5-(2,3-dihydroxypropoxy)-3-(indol-3-ylmethylene)-2-oxindole;  
5-aminomethyl-3-(indol-3-ylmethylene)-2-oxindole;  
5-amidino-3-(indol-3-ylmethylene)-2-oxindole;  
10 5-hydroxymethyl-3-(indol-3-ylmethylene)-2-oxindole;  
5-phosphonoxy-3-(indol-3-ylmethylene)-2-oxindole;  
3-(5-sulfoindol-3-ylmethylene)-2-oxindole;  
3-(5-sulfamoylindol-3-ylmethylene)-2-oxindole;  
3-(5-carbomethoxyindol-3-ylmethylene)-2-oxindole;  
15 3-(5-diethanolamino-3-indolylmethylene)-2-oxindole;  
3-[5-(2,3-dihydroxypropylamino)-3-indolylmethylene]-2-oxindole;  
3-(5-ureido-3-indolylmethylene)-2-oxindole;  
3-(5-guanidino-3-indolylmethylene)-2-oxindole;  
20 3-(5-glyceroylamido-3-indolylmethylene)-2-oxindole;  
3-[5-(3-piperidinopropionylamino)-3-indolylmethylene]-2-oxindole;  
3-(5-mesylamino-3-indolylmethylene)-2-oxindole;  
3-(5-glycoloyloxy-3-indolylmethylene)-2-oxindole;  
25 3-[5-(2,3-dihydroxypropoxy)-3-indolylmethylene]-2-oxindole;  
3-(5-amin methyl-3-indolylmethylene)-2-oxindol ;  
3-(5-amidino-3-ind lylmethylene)-2-oxindol ;

-9-

- 3-(5-hydroxymethyl-3-indolylmethylene)-2-oxindole;  
3-(5-phosphonooxy-3-indolylmethylene)-2-oxindole;  
5-sulfo-3-(naphth-2-ylmethylene)-2-oxindole;  
5-sulfamoyl-3-(naphth-2-ylmethylene)-2-oxindole;  
5 5-carbomethoxy-3-(naphth-2-ylmethylene)-2-oxindole;  
5-diethanolamino-3-(naphth-2-ylmethylene)-2-oxindole;  
5-(2,3-dihydroxypropylamino)-3-(naphth-2-ylmethylene)-2-oxindole;  
5-ureido-3-(naphth-2-ylmethylene)-2-oxindole;  
10 5-guanidino-3-(naphth-2-ylmethylene)-2-oxindole;  
5-glyceroylamido-3-(naphth-2-ylmethylene)-2-oxindole;  
5-(3-piperidinopropionylamino)-3-(naphth-2-ylmethylene)-2-oxindole;  
5-mesylamino-3-(naphth-2-ylmethylene)-2-oxindole;  
15 5-glycoloyloxy-3-(naphth-2-ylmethylene)-2-oxindole;  
5-(2,3-dihydroxypropoxy)-3-(naphth-2-ylmethylene)-2-oxindole;  
5-aminomethyl-3-(naphth-2-ylmethylene)-2-oxindole;  
5-amidino-3-(naphth-2-ylmethylene)-2-oxindole;  
20 5-hydroxymethyl-3-(naphth-2-ylmethylene)-2-oxindole;  
5-phosphonooxy-3-(naphth-2-ylmethylene)-2-oxindole;  
5-sulfo-3-(1-hydroxytetral-2-ylmethylene)-2-oxindole;  
5-sulfo-3-(4-hydroxytetral-2-ylmethylene)-2-oxindole;  
5-(3-piperidinopropionylamino)-3-(5-methoxyindol-3-ylmethylene)-2-oxindole;  
25 3-[5-(p-chlorophenyl)sulfonylamidoindol-3-yl-methylene]-2-oxindole;  
5-carboethoxy-3-(3-hydroxytetral-2-ylmethylene)-2-

-10-

oxindole;  
5-carboethoxy-3-(quinol-4-ylmethylene)-2-oxindole;  
5-carboethoxy-3-(5-methoxyindol-3-ylmethylene)-2-oxindole;  
5-3-(5-carboethoxyindol-3-ylmethylene)-2-oxindole;  
5-carbobenzyloxy-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole;  
5-carbobenzyloxy-3-(quinol-4-ylmethylene)-2-oxindole;  
5-carbobenzyloxy-3-(5-methoxyindol-3-ylmethylen )-2-oxindole;  
10 3-(5-carbobenzyloxyindol-3-ylmethylene)-2-oxindole;  
5-phenylcarbamoyl-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole;  
5-phenylcarbamoyl-3-(quinol-4-ylmethylene)-2-oxindole;  
15 5-phenylcarbamoyl-3-(5-methoxyindol-3-ylmethylen )-2-oxindole;  
3-(5-phenylcarbamoylindol-3-ylmethylene)-2-oxindole;  
5-benzylcarbamoyl-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole;  
20 5-benzylcarbamoyl-3-(quinol-4-ylmethylene)-2-oxindole;  
5-benzylcarbamoyl-3-(5-methoxyindol-3-ylmethylen )-2-oxindole;  
3-(5-benzylcarbamoylindol-3-ylmethylene)-2-oxindole;  
5-carboethoxy-3-(8-hydroxyquinol-5-ylmethylene)-2-oxindole;  
25 5-benzylcarbamoyl-3-(8-hydroxyquinol-5-ylmethylen e)-2-oxindole;

-11-

5-(2,3-dihydroxypropylamino)-3-(5-methoxy-3-indolyl-methylene)-2-oxindole;

5-sulfo-3-(5-methoxyindol-3-ylmethylene)-2-oxindole;

5-amidino-3-(5-methoxyindol-3-ylmethylene)-2-oxindole,

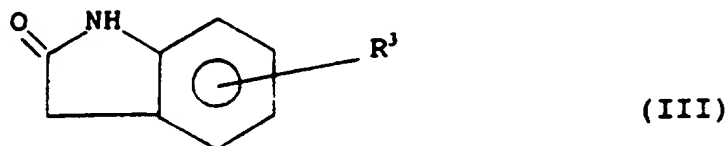
5 and the pharmaceutically acceptable salts thereof.

The compounds of the invention, and the salts thereof, can be obtained by a process comprising:

a) condensation of an aldehyde of formula (II)

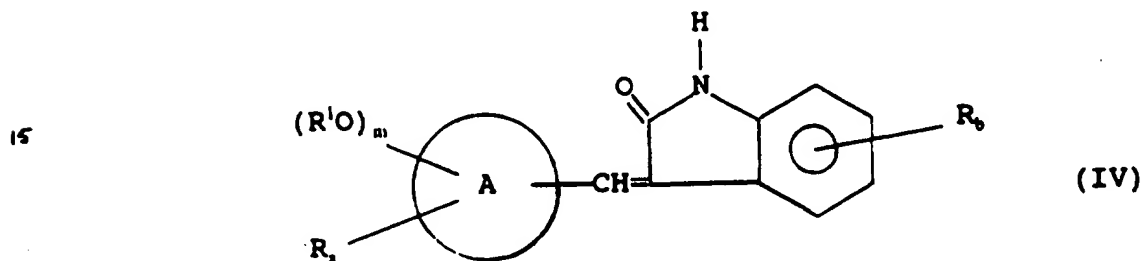


10 wherein A, R<sup>1</sup>, R<sup>2</sup> and m are as defined above, with a compound of formula (III)




wherein R<sup>3</sup> is as defined above; or

b) N-alkylation of a compound of formula (IV)



-12-

wherein  $R^1$ , A and m are as defined above, and one of  $R_a$  and  $R_b$  is  $-NH_2$  and the other is hydrogen, thus obtaining a compound of formula (I) wherein one of  $R^2$  and  $R^3$  is a group  $-NHR^9$  or  $-N(R^9)_2$ , in which  $R^9$  is as defined above and the other is hydrogen; or

c) N-acylating a compound of formula (IV), as defined above, thus obtaining a compound of formula (I) wherein one of  $R^2$  and  $R^3$  is a  $-NHCOR^{10}$  or  $-NHCO(CH_2)_p-N$   Z group, in which  $R^{10}$ , p and Z are as defined above and the other is hydrogen; or

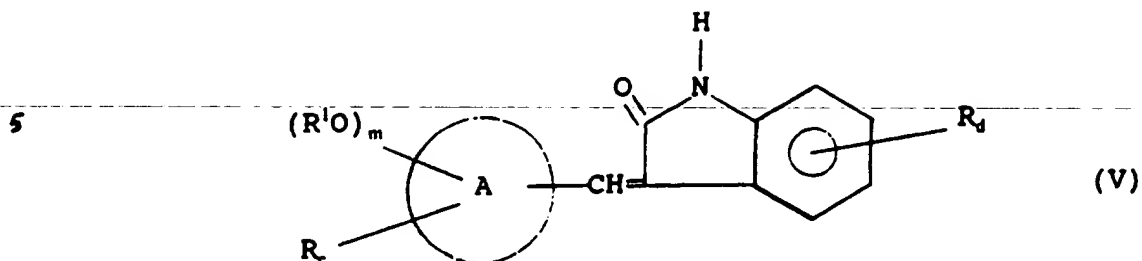
d) N-sulfonylation of a compound of formula (IV), as defined above, thus obtaining a compound of formula (I), wherein one of  $R^2$  and  $R^3$  is hydrogen and the other is  $-NHSO_2R^8$  in which  $R^8$  is as defined above; or

e) N-amidination of a compound of formula (IV), as defined above, thus obtaining a compound of formula (I), wherein one of  $R^2$  and  $R^3$  is hydrogen and the other is  $-NHC(NH_2)=NH$ ; or

f) N-carbamoylation of a compound of formula (IV), as defined above, thus obtaining a compound of formula (I), wherein one of  $R^2$  and  $R^3$  is hydrogen and the other is  $-NHCONH_2$ ; or

-13-

g) O-alkylation of a compound of formula (V)



wherein  $R^1$ ,  $m$  and  $A$  are as defined above, one of  $R_4$  and  $R_4$  is  $-OH$  and the other is hydrogen, thus obtaining a compound of formula (I) wherein one of  $R^2$  and  $R^3$  is a group  $-OR^9$  in which  $R^9$  is as defined above and the other is hydrogen; or

10

h) O-acylating of a compound of formula (V), as defined above, thus obtaining a compound of formula (I) wherein one of  $R^2$  and  $R^3$  is hydrogen and the other is a group  $-OOCR^{10}$  in which  $R^{10}$  is as defined above; or

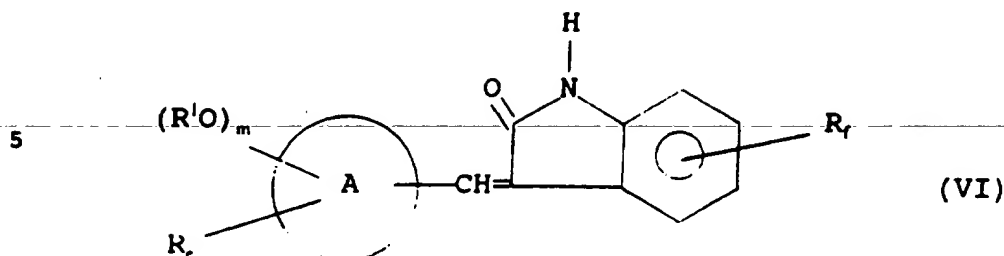
15

i) O-phosphorylation of a compound of formula (V), as defined above, thus obtaining a compound of formula (I), wherein one of  $R^2$  and  $R^3$  is hydrogen and the other is  $-OPO(OH)_2$ ; or

20

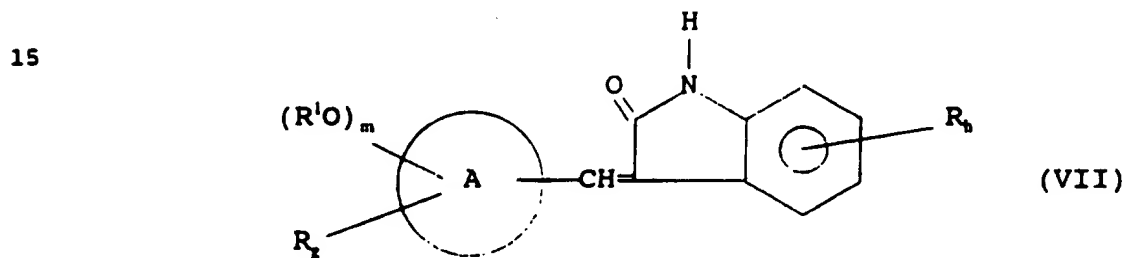
-14-

k) esterification of a compound of formula (VI)



wherein  $R^1$ ,  $m$  and  $A$  are as defined above and one of  $R_e$  and  $R_f$  is  $-\text{COOH}$  and the other is hydrogen, thus  
 10 obtaining a compound of formula (I), wherein one of  $R^2$  and  $R^3$  is hydrogen and the other is  $-\text{COOR}^6$  in which  $R^6$  is as defined above; or

l) ammonia addition to a compound of formula (VII)

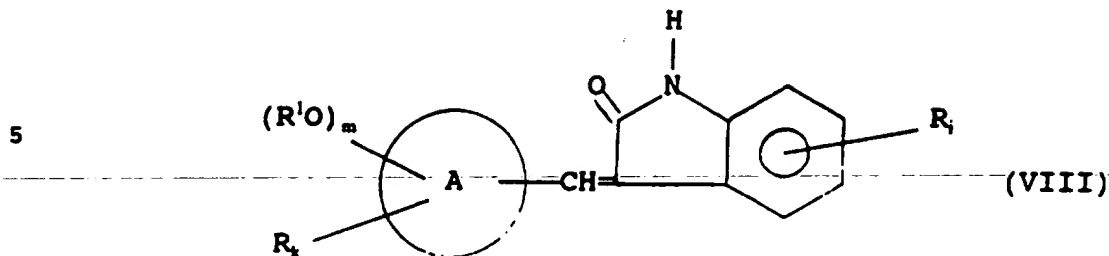



20 wherein  $R^1$ ,  $A$  and  $m$  are as defined above and one of  $R_e$  and  $R_b$  is  $-\text{CN}$  and the other is hydrogen, thus obtaining a compound of formula (I), wherein one of  $R^2$  and  $R^3$  is hydrogen and the other is  $-\text{C}(\text{NH}_2)=\text{NH}$ ; or



-15-

m) amination of a compound of formula (VIII)



wherein  $R^1$ ,  $m$  and  $A$  are as defined above and one of  $R_1$  and  $R_2$  is  $-CH_2Cl$  and the other is hydrogen, thus obtaining a compound of formula (I), wherein one of  $R^2$  and  $R^3$  is hydrogen and the other is a  $-CH_2NH_2$  or  $-CH_2-N$    $Z$  group in which  $Z$  is as defined above; and, if desired, the conversion of a compound of formula (I) into another compound of formula (I), and/or, if desired, the conversion of a compound of formula (I) into a salt thereof, and/or, if desired, converting a salt of a compound of formula (I) into a free compound of formula (I), and/or, if desired, separating a mixture of isomers of a compound of formula (I) into the single isomers.

10

15

20

The condensation of a compound of formula (II) with a compound of formula (III) according to process step a) may be carried out using known methods, e.g. under the conditions of the Knoevenagel reaction as described, e.g., by G. Jones in Organic Reactions 15, 204 (1967). Suitable reaction catalysts are organic bases such as pyridine, piperidine, diethylamine or triethylamine.


25

-16-

The condensation may be performed in an inert organic solvent, e.g. pyridine, a lower alkanol, e.g. ethanol, methanol, benzene or dioxane at temperatures ranging from about 0 to about 100°C. Preferably the reaction is  
5 carried out in warm ethanol solution in the presence of piperidine catalyst.

The N-alkylation according to process step b) may be carried out according to known methods, e.g. as described in Houben-Weyl, Methoden der Organischen Chemie, Vol.  
10 XI/I, page 311 (1957). In particular, in order to obtain compounds of formula (I) wherein R<sup>2</sup> or R<sup>3</sup> is -N(CH<sub>2</sub>CH<sub>2</sub>OH)<sub>2</sub>, the aromatic amine of formula (IV) is reacted with ethylene oxide in water, alcoholic or hydroalcoholic solution at temperatures ranging, e.g., from 0 to 100°C.  
15 Preferably the reaction is carried out in hydroalcoholic suspension at about 70-80°C by introducing ethylene oxide gas. N-alkylation according to process step b) in order to obtain compounds of formula (I) wherein R<sup>2</sup> or R<sup>3</sup> is, for instance, -NHCH<sub>2</sub>-CHOH-CH<sub>2</sub>OH can be carried out by  
20 reductive amination, i.e. by condensation of the aromatic amine of formula (IV) with an aldehyde of formula CH<sub>2</sub>OHCHOHCHO in the presence of a reducing agent, e.g. as described in Tietze and Eiche, Reactions and Synthesis in the Organic Chemistry Laboratory, page 77 (1988). Thus to  
25 the alcoholic solution of the aromatic amine and the aldehyde is added portionwise sodium cyanoborohydride at temperatures ranging from 0°C to reflux temperature .

-17-

Th N-acylation according to process step c) may be carried out by known methods, e.g. as described in Houben-Weyl, Methoden der Organischen Chemie, vol. E5, page 960 (1985). Thus the aromatic amine is reacted with  
5 the corresponding carboxylic acid of formula  $R^{10}$ -COOH or  
  $N-(CH_2)_p-COOH$ , wherein  $R^{10}$ , Z and p are as defined above, by using a condensing agent such as dicyclohexylcarbodiimide (DCCD). Preferably equimolar amounts of amine, acid and DCCD are used in an inert solvent such as  
10 THF or benzene at temperatures from about 0°C to 50°C.

The N-sulfonylation according to process step d) may be carried out by known methods, e.g. as described in Houben-Weyl, Vol. IX, page 609 (1955). Thus equimolar amounts of aromatic amine and sulfochloride of general  
15 formula  $R^1-SO_2Cl$  are reacted in pyridine solution at temperatures from about -10°C to 50°C.

The N-amidination according to process step e) may be carried out, e.g., as described by P.D. Davis et al. in J. Med. Chem. 1992, 35, 994. Thus the aromatic amine is  
20 treated with about 1.5 molequivalents of 3,5-dimethylpyrazole-1-carboxamide in refluxing ethanol in the presence of about 1 molequivalent of  $NaHCO_3$ .

The N-carbamoylation according to process step f) may be carried out, e.g., as described in Houben-Weyl, Vol. E4,  
25 page 362 (1983). Thus the aromatic amine salt, preferably

-18-

the hydrochloride salt, is reacted with an alkali metal cyanate, preferably NaOCN or KOCN, in aqueous or hydroalcoholic solution at temperatures ranging from about 50°C to about 100°C.

5 The O-alkylation according to process step g) may be performed, e.g., as described in Houben-Weyl, Vol. VI/3, page 54 (1965). Thus the phenol is first transformed into its alkali metal salt by treatment with an alkali metal alcoholate or hydroxide or amide. Then the phenolate is  
10 reacted with a halogenide of general formula  $R^9-X$ , in which  $R^9$  is as defined above and X is chlorine or bromine, in an inert solvent such as benzene or THF at temperatures ranging from room to reflux temperatures. Preferably the reaction is performed in benzene solution  
15 by reacting the phenol first with a stoichiometric amount of  $NaNH_2$  at room temperature and then with an excess of halogenide at reflux temperature.

The O-acylation according to process step h) may be carried out by known methods, e.g. as reported in Houben-  
20 Weyl, Vol. VIII, page 543 (1952). Thus the phenol is reacted with the acid halide of general formula  $R^{10}-COCl$ , wherein  $R^{10}$  is as defined above, in the presence of an organic base such as pyridine or triethylamine at temperatures ranging from about 0° to 50°C in an appropriate organic solvent. Alternatively the phenol is  
25 reacted with the acid  $R^{10}-COOH$ , in which  $R^{10}$  is as defined

-19-

above, in the presence of a condensing agent such as dicyclohexylcarbodiimide (DCCD). Preferably equimolar amounts of phenol and DCCD are used and the reaction is performed in an inert solvent such as THF or benzene at

5    temperatures from about 0° to 50°C.

The O-phosphorylation according to process step i) can be carried out by known methods, e.g. as described in Houben-Weyl, Vol. XII/2, page 143 (1964). Thus the phenol is reacted with phosphoric acid or a derivative thereof

10    in water or hydroalcoholic solution at temperatures ranging from room to reflux temperatures. Preferably the reaction is performed in polyphosphoric acid (mixture of  $H_3PO_4$  and  $P_2O_5$ ) which acts as reactant and solvent at temperatures ranging from about 50° to 100°C.

15    The esterification according to process step k) can be carried out by well known methods, e.g. as reported in Houben-Weyl, Vol. VIII, page 508 (1952). Thus the mixture of acid and alcohol, dissolved in an inert solvent such as benzene and chloroform, is heated to reflux in the

20    presence of a mineral acid such as  $H_2SO_4$  or  $HCl$ . Preferably the water formed is removed by azeotropic distillation in a Dean-Stark condenser.

The nitrile transformation according to process step l) can be carried out by known methods, as described in

25    Houben-Weyl, Vol. VIII, pages 697 and 702 (1952). Thus to

-20-

the th r or chloroform solution of the nitrile is added  
an equimolar amount of ethanol and the solution is  
saturated with Hcl gas. The resulting iminoether  
hydrochloride is then transformed into the amidine by  
5 reaction with ammonia in absolute ethanol at room  
temperature.

The amination according to process step m) can be  
performed by known methods, e.g. as reported in Houben-  
Weyl, Vol.XI/I, page 24 (1957). Thus a mixture of  
10 chloromethyl compound and secondary amino derivative is  
treated at temperatures from about 50° to about 150°C  
until the reaction is complete. Otherwise, the amination  
of the chloromethyl compound in order to obtain an  
aminomethyl compound can be performed according to th  
15 Delépine reaction as described by S. J. Augyal in Organic  
Reactions 8, 197 (1959). Thus the benzylhalide is first  
reacted with hexamethylenetetramine to give a quaternary  
ammonium salt which is then cleaved by acid hydrolysis.

The optional salification of a compound of formula (I) as  
20 well as the conversion of the salt into the corresponding  
free compound and the separation of a mixture of isomers  
into the single isomers as well as the conversion of a  
compound of formula (I) into another compound of formula  
(I) may be carried ut according to known methods.

25 For example, the amidation of a comp und of formula (I),  
wherein R<sup>2</sup> or R<sup>3</sup> is -SO<sub>3</sub>H, so as to obtain a compound of

-21-

formula (I) wherein  $R^2$  or  $R^3$  is  $-\text{SO}_2\text{NHR}^5$  or  $-\text{SO}_2-\text{N} \begin{array}{c} \diagup \quad \diagdown \\ \diagdown \quad \diagup \end{array} \text{Z}$ , in which  $R^5$  and  $Z$  are as defined above, may be carried out by known methods, e.g. as described at process step d). The conversion of a compound of formula (I) in which  $R^2$

5 or  $R^3$  is  $-\text{CH}_2\text{NH}_2$  into a compound of formula (I) wherein  $R^2$  or  $R^3$  is  $-\text{CH}_2\text{NH}-\text{C}(\text{NH}_2)=\text{NH}$  may be carried out by known amidination methods, e.g. as described above at process step e).

The esterification of a compound of formula (I) wherein 10  $R^2$  or  $R^3$  is  $\text{CH}_2\text{OH}$  in order to obtain compounds of formula (I) wherein  $R^2$  or  $R^3$  is  $-\text{CH}_2\text{OOCR}^{10}$ , wherein  $R^{10}$  is as defined above, may be carried out in an analogous manner as in process step k).

The conversion of a compound of formula (I), in which  $R^2$  15 or  $R^3$  is  $-\text{CH}_2\text{OH}$ , into the corresponding compound of formula (I) wherein  $R^2$  or  $R^3$  is  $-\text{CH}_2\text{OPO}(\text{OH})_2$ , can be performed as described above at process step i).

The conversion of a compound of formula (I), wherein  $R^2$  or  $R^3$  is  $-\text{COOR}^6$  and in which  $R^6$  is preferably methyl, into 20 the corresponding compound of formula (I) wherein  $R^2$  or  $R^3$  is  $-\text{CONHR}^7$  in which  $R^7$  is phenyl or benzyl, can be carried out by aminolysis, e.g. as reported in Houben-Weyl, Vol. E5, page 983 (1985). Preferably the carbomethoxy compound is reacted with the amine compound of 25 formula  $\text{H}_2\text{NPh}$  or  $\text{H}_2\text{NCH}_2\text{Ph}$  at reflux temperature by removing continuously the methanol formed by distillation.

Similarly the carbomethoxy compound can be reacted with

-22-

a compound of formula  $\text{H}-\text{N} \begin{array}{c} \diagup \diagdown \\ \text{---} \end{array} \text{Z}$  in which Z is as defined above, at reflux temperature by removing continuously the methanol formed by distillation, thus obtaining a compound of formula (I) in which one of  $\text{R}^1$  and  $\text{R}^2$  is

5  $-\text{CON} \begin{array}{c} \diagup \diagdown \\ \text{---} \end{array} \text{Z}$  and the other is hydrogen.

The optional salification of a compound of formula (I) as well as the conversion of the salt into the free compound and the separation of a mixture of isomers into the single isomers may be carried out by conventional

10 methods. For instance, the separation of a mixture of geometric isomers, e.g. cis- and trans-isomers, may be carried out by fractional crystallization from a suitable solvent or by chromatography, either column chromatography or high pressure liquid chromatography.

15 The compounds of formula (II) may be obtained according to known methods from compounds of formula (IX)



20 wherein A,  $\text{R}^1$ ,  $\text{R}^2$  and m are as defined above. E.g. the 3-formylindole compound of formula (II) wherein A is indole and  $\text{R}^1$ ,  $\text{R}^2$  and m are as defined above can be obtained from an indole compound of general formula (IX) by formylation with N-m thylformanilide and  $\text{POCl}_3$  according to the well

25 known Vilsmeier-Haack method (for a review see W.G.



-23-

Jackson et al. in J. Am. Chem. Soc. 1981, 103, 533). The 2-formylindole derivatives are obtained when the 3-position is occupied.

In the case compound (IX) contains phenolic groups, i.e.

5 R'O is hydroxy, the well known Reimer-Tiemann method can be applied. Thus the phenolic compound is treated with CHCl<sub>3</sub> and alkali hydroxides in an aqueous or hydroalcoholic solution. Another useful method for the synthesis of aromatic or phenolic aldehydes has been  
10 reported by H. Gross et al. in Chem. Ber. 1963, 96, 308. Accordingly a compound of formula (IX), in which the OR'<sup>1</sup> group may be present or not, can be treated with 1,1-dichlorodimethylether in the presence of a Friedel-Crafts catalyst such as TiCl<sub>4</sub> or AlCl<sub>3</sub> in an inert solvent like  
15 CH<sub>2</sub>Cl<sub>2</sub> or PhNO<sub>2</sub> at temperatures ranging from about 0° to 60°C.

The compounds of formula IV, V, VI VII and VIII can be obtained by condensation of a suitable 2-oxindole with a suitable compound of formula (II) according to process  
20 step a) as described above.

The compounds of formula (III) and (IX) are known or may be obtained by known methods from known compounds.

When in the new compounds of the present invention and in the intermediate products used for their preparation  
25 there are groups present which need to be protected before the above-described reactions are performed, they may be protected before the reaction takes place and then deprotected at the end of the reaction, according to well

-24-

known methods in organic chemistry.

### PHARMACOLOGY

The compounds of the invention possess specific tyrosine kinase inhibiting activity. It is believed that tyrosine kinase inhibitors may be of great importance in the control of uncontrolled cellular reproduction, i.e. in cellular reproduction disorders.

Recent studies on the molecular basis of neoplastic transformation have identified a family of genes, designated oncogenes, whose aberrant expression causes tumorigenesis. For example, the RNA tumour viruses possess such an oncogene sequence whose expression determines neoplastic conversion of infected cells. Several of their oncogene-encoded proteins, such as pp60<sup>v-src</sup>, p70<sup>src-yes</sup>, p130<sup>src-fps</sup> and p70<sup>src-fgr</sup> display protein tyrosine kinase activity, that is they catalyse the transfer of the  $\gamma$ -phosphate from adenosine triphosphate (ATP) to tyrosine residues in protein substrate. In normal cells, several growth factor receptors, for example the receptors for PDGF, EGF,  $\alpha$ -TGF and insulin, display tyrosine kinase activity.

Binding of the growth factor (GF) activates the receptors tyrosine kinase to undergo autophosphorylation and to phosphorylate closely adjacent molecules on tyrosine. Therefore, it is thought that the phosphorylation of these tyrosine kinase receptors plays an important role in signal transduction and that the principal function of

-25-

tyr sine kinase activity in normal cells is to regulate cell growth. Perturbation of this activity by oncogenic tyrosine kinases that are either overproduced and/or display altered substrate specificity may cause loss of growth control and/or neoplastic transformation. Accordingly, a specific inhibitor of tyrosine kinase can be useful in investigating the mechanism of cancerogenesis, cell proliferation and differentiations and it can be effective in prevention and chemotherapy of cancer and other pathological proliferative conditions. Hence the compounds according to the present invention can be useful in the treatment of pathological proliferation disorders in mammals, including humans. A human or animal, e.g. a mammal, can thus be treated by a method comprising the administration thereto of a therapeutically effective amount of one of the compounds of the invention. In this way the condition of the human or animal may be improved. Amelioration of the disease state or disorder from which the human or animal is suffering can be achieved. Typical examples of such disorders are benign and malignant tumours, including leukaemia such as myeloblastic leukaemia, lymphoma, sarcoma, neuroblastoma, Wilm's tumour, malignant neoplasm of the bladder, breast, lung or thyroid, neoplasias of pith lial origin, such as mammacarcinoma. Mor ver, they can be useful in th treatment of epidermal hyperprolif ration, such as psoriasis. Th compounds of the invention can also be useful in inhibiting the d velop-

-26-

ment of the atheromatous plaque and restenosis, in the control of angiogenesis, as anti-metastatic agents and in treating diabetic complications. They have also utility in the control of immune system diseases, e.g. as immuno-

5 suppressants, as far as protein tyrosine kinases are involved in these diseases.

The tyrosine specific protein kinase activity of the compounds of the invention is shown, e.g., by the fact that they are active in the in vitro and in vivo test  
10 described herebelow.

#### In-vitro Assay

##### p45 v-abl Kinase Purification

The enzyme used in our test was the p45 v-abl tyrosine kinase which represents the catalytic domain of the  
15 Abelson tyrosine kinase (isolated from the Abelson murine leukaemia virus). The p45 v-abl kinase was produced and isolated as described by Wang et al. in J. Biol. Chem. 260, 64 (1985) and by Ferguson et al. in J. Biol. Chem. 260, 3652 (1985) and in Biochem. J. 257, 321 (1989).

##### p45 v-abl Kinase Assay

(Val<sup>5</sup>)-Angiotensin II phosphorylation was performed by incubation with 40 ng of purified abl-kinase and ( $\gamma$ -<sup>32</sup>P)-ATP, in 50  $\mu$ l of buffer containing Tris-HCl 25 mM, pH 8.0, MgCl<sub>2</sub> 10 mM and dithiothreitol 0.1 mM (kinase  
25 buffer). The reaction mixture was incubated for the indicated time at 30°C and the reaction stopped by adding 50  $\mu$ l of 5 % trichloroacetic acid. After a brief incubation on ice, tubes were centrifuged. The super-

-27-

natants were spotted on phosphocellulose paper squares (Whatman P-81) and washed extensively in acetic acid. The radioactivity bound to dried phosphocellulose squares was measured in a liquid scintillation counter.  $IC_{50}$  values were calculated from triplicated determinations of each experimental point. Each inhibitor was tested at concentrations ranging from 0 to 400  $\mu$ g in the presence of fixed concentrations of peptide (2 Mm) and ATP (50  $\mu$ M).

#### 10 In-vivo Assay

##### K562 Cell Growth Inhibition Assay

K562 cells, a human myelogenous leukemia cell line, were seeded into a 24 wells tissue culture plate (Falcon 3047) (10000/well) in the presence of increasing concentrations of the compounds. After 72 h, cells were harvested and were counted using a cell counter (Coulter Counter - ZM). The percent of inhibition was evaluated in respect to the untreated control cells.

The inhibitory activity data for two representative compounds according to the present invention, obtained both in the in vitro p45 v-abl kinase assay and the in vivo human chronic myeloid leukemia K562 cell growth inhibition assay described above, are set out in the following Table I.

-28-

Table I. Inhibition of p45 v-abl kinase and K562 cell growth.

| 5  | Compound   | IC <sub>50</sub> (μM) |      |
|----|--|-----------------------|------|
|    |  | v-abl                 | K562 |
|    | 5-(3-piperidinopropionylamino)-3-(5-methoxyindol-3-ylmethylene)-2-oxindole.HCl | 1.73                  | 3.7  |
| 10 | 3-carbethoxy-3-(5-methoxyindol-3-ylmethylene)-2-oxindole                       | 1.99                  | 2.34 |

As can be appreciated from the activity data shown in Table I, the compounds according to the invention are endowed with valuable biological properties.

In view of their high activity and low toxicity, the compounds of the invention can be used safely in medicine.

The compounds of the invention can be administered in a variety of dosage forms, e.g. orally, in the form of tablets, capsules, sugar- or film-coated tablets, liquid solutions or suspensions; rectally, in the form of

-29-

suppositories; parenterally, e.g. intramuscularly, or by intravenous injection or infusion; or topically. The dosage depends on the age, weight, condition of the patient and administration route. For example, the dosage adopted for oral administration to adult humans for the compound 5-sulfo-3-(3-hydroxytetralyl-2-ylmethylene)-2-oxindole may range from about 10 to about 150-200 mg per dose, from 1 to 5 times daily. Of course, these dosage regimens may be adjusted to provide the optimal therapeutic response.

The invention includes pharmaceutical compositions comprising a compound of formula (I) or a pharmaceutically acceptable salt thereof in association with a pharmaceutically acceptable excipient (which can be a carrier or diluent).

The pharmaceutical compositions containing the compounds of the invention are usually prepared following conventional methods and are administered in a pharmaceutically suitable form.

For example, the solid oral forms may contain, together with the active compound, diluents, e.g. lactose, dextrose, saccharose, cellulose, corn starch or potato starch; lubricants, e.g. silica, talc, stearic acid, magnesium or calcium stearate, and/or polyethylene glycols; binding agents, e.g. starches, arabic gums, gelatin, methylcellulose, carboxymethylcellulose or polyvinyl pyrrolidone; disaggregating agents, e.g. a starch, alginic acid, alginates or sodium starch

-30-

glycolate, effervescing mixtures; dyestuffs; wetteners; wetting agents, such as lecithin, polysorbates, lauryl-sulphates; and, in general, non-toxic and pharmacologically inactive substances used in pharmaceutical

5 formulations. Said pharmaceutical preparations may be manufactured in known manner, for example by means of mixing, granulating, tableting, sugar-coating or film-coating processes.

The liquid dispersion for oral administration may be,  
10 e.g., syrups, emulsions and suspensions.

The syrup may contain as carrier, for example, saccharose or saccharose with glycerine and/or mannitol and/or sorbitol.

The suspensions and the emulsions may contain as carrier,  
15 for example, a natural gum, agar, sodium alginate, pectin, methylcellulose, carboxymethylcellulose or polyvinyl alcohol.

The suspensions or solutions for intramuscular injections may contain, together with the active compound, a  
20 pharmaceutically acceptable carrier, e.g. sterile water, olive oil, ethyl oleate, glycols, e.g. propylene glycol, and, if desired, a suitable amount of lidocaine hydrochloride.

The solutions for intravenous injections or infusion may  
25 contain as carrier, for example, sterile water or, preferably, they may be in the form of sterile aqueous, isotonic saline solutions.

The suppositories may contain, together with the active



-31-

compound, a pharmaceutically acceptable carrier, e.g. cocoa-butter, polyethylene glycol, a polyoxyethylene sorbitan fatty acid ester surfactant or lecithin.

Compositions for topical application, e.g. creams, lotions or pastes, can be prepared by admixing the active ingredient with a conventional oleaginous or emulsifying excipient.

A further object of the present invention is a combined method of treatment of cancer or of amelioration of the conditions of mammals, including humans, suffering from cancer, said method comprising administering

- 1) a compound of the invention, or a pharmaceutically acceptable salt thereof,
- and
- 2) an additional antitumour agent, in amounts and close enough together in time sufficient to produce a therapeutically useful effect.

The present invention also provides products containing a compound of the invention, or a pharmaceutically acceptable salt thereof, and an additional antitumour agent as a combined preparation for simultaneous, separate or sequential use in anti-cancer therapy.

The term "antitumour agent" is meant to comprise both a single antitumour drug and "cocktails" i.e. a mixture of such drugs, according to the clinical practice.

Examples of antitumour agents that can be formulated with a compound of the invention or, alternatively, can be

-32-

administered in a combined method of treatment, include doxorubicin, daunomycin, epirubicin, idarubicin, etoposide, fluorouracil, melphalan, cyclophosphamide, bleomycin, vinblastin and mitomycin or a mixture of two  
5 or more thereof.

The compounds of the invention can therefore be used in a treatment to ameliorate a cancer. They may be administered to a patient suffering from a cancer treatable with an antitumour agent, for example an  
10 anthracycline glycoside such as doxorubicin, daunomycin, epirubicin or idarubicin as mentioned above, together with the antitumour agent.

A compound of the invention and an antitumour agent such as an anthracycline glycoside can be administered to  
15 improve the condition of a patient having a leukaemia such as myeloblastic leukaemia, lymphoma, sarcoma, neuroblastoma, Wilm's tumour or malignant neoplasm of the bladder, breast, lung or thyroid.

The following examples illustrate but do not limit the  
20 invention.

-33-

Example 1

## 5-Sulfamoyl-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole

A solution of 3-hydroxy-2-tetralinaldehyde (1.762 g, 10 mmol), 5-sulfamoyl-2-oxindole (1.802 g, 10 mmol) and  
 5 piperidine (0.255 g, 3 mmol) in anhydrous ethanol (50 ml) was heated for 3 h at reflux. The reaction mixture was chilled to 5-10°C, the precipitate filtered, the residue washed with ice-cold ethanol and then dried under vacuum. Almost pure title compound was so obtained in about 80 %  
 10 yield (2.707 g). Compounds of higher purity were obtained by crystallization from ethanol.

|                      |        |         |        |        |        |
|----------------------|--------|---------|--------|--------|--------|
| $C_{19}H_{18}N_2O_4$ | calcd: | C 61.61 | H 4.90 | N 7.56 | S 8.66 |
|                      | found: | C 61.55 | H 4.85 | N 7.51 | S 8.55 |

MS m/z 370.

15 IR  $\text{cm}^{-1}$ : 3500-2600 (NH, OH), 1700, 1695 (amide),  
 1600, 1580 (arom)

According to the above described procedure and starting from the appropriate compound of formula (II) and of formula (III), respectively, one can prepare the  
 20 following compounds as single E- or Z-isomers, as well as their E,Z-mixtures:

5-sulfamoyl-3-[1,4-dihydroxytetral-2-ylmethylen]-2-oxindole;

5-sulfamoyl-3-[1-hydroxytetral-2-ylmethylen]-2-oxindole;

25 5-sulfamoyl-3-[3-hydroxytetral-2-ylmethylene]-2-oxindole;

-34-

- 5-sulfamoyl-3-[4-hydroxytetral-1-ylmethylene]-2-oxindole;  
5-carbomethoxy-3-[1,4-dihydroxytetral-2-ylmethylene]-2-oxindole;  
5-carbomethoxy-3-[3-hydroxytetral-2-ylmethylene]-2-oxindole;  
5 oxindole;  
5-[N,N-(4-hydroxyethyl)piperazinylcarbonyl]-3-[1,4-dihydroxytetral-2-ylmethylene]-2-oxindole;  
5-diethanolamino-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
10 5-(2,3-dihydroxypropylamino)-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-ureido-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-guanidino-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
15 oxindole;  
5-glyceroylamido-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-(3-piperidinopropionylamino)-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
20 5-mesylamino-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-glycoloyloxy-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-(2,3-dihydroxypropoxy)-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
25 5-aminomethyl-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-amidino-3-(1,4-dihydroxytetral-2-ylmethylene)-2-

-35-

- oxindole;  
5-hydroxymethyl-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-sulfo-3-(quinol-4-ylmethylene)-2-oxindole;  
5-sulfamoyl-3-(quinol-4-ylmethylene)-2-oxindole;  
5-carbomethoxy-3-(quinol-4-ylmethylene)-2-oxindole;  
5-diethanolamino-3-(quinol-4-ylmethylene)-2-oxindole;  
5-(2,3-dihydroxypropylamino)-3-(quinol-4-ylmethylene)-2-oxindole;  
5-ureido-3-(quinol-4-ylmethylene)-2-oxindole;  
5-guanidino-3-(quinol-4-ylmethylene)-2-oxindole;  
5-glyceroylamido-3-(quinol-4-ylmethylene)-2-oxindole;  
5-(3-piperidinopropionylamino)-3-(quinol-4-ylmethylene)-2-oxindole;  
5-mesylamino-3-(quinol-4-ylmethylene)-2-oxindole;  
5-glycoloyloxy-3-(quinol-4-ylmethylene)-2-oxindole;  
5-(2,3-dihydroxypropoxy)-3-(quinol-4-ylmethylene)-2-oxindole;  
5-aminomethyl-3-(quinol-4-ylmethylene)-2-oxindole;  
5-amidino-3-(quinol-4-ylmethylene)-2-oxindole;  
5-hydroxymethyl-3-(quinol-4-ylmethylene)-2-oxindole;  
5-sulfamoyl-3-(indol-3-ylmethylene)-2-oxindole;  
5-carbomethoxy-3-(indol-3-ylmethylene)-2-oxindole;  
5-diethanolamino-3-(indol-3-ylmethylene)-2-oxindole;  
5-(2,3-dihydroxypropylamino)-3-(indol-3-ylmethylene)-2-oxindole;  
5-ureido-3-(indol-3-ylmethylene)-2-oxindole;  
5-guanidino-3-(indol-3-ylmethylene)-2-oxindole;

-36-

5-glyceroylamido-3-(indol-3-ylm thylen )-2-oxindole;

5-(3-piperidinopropionylamino)-3-(indol-3-ylmethylen)-2-oxindole;

5-mesylamino-3-(indol-3-ylmethylen)-2-oxindole;

5-glycoloyloxy-3-(indol-3-ylmethylen)-2-oxindole;

5-(2,3-dihydroxypropoxy)-3-(indol-3-ylmethylen)-2-oxindole;

5-aminomethyl-3-(indol-3-ylmethylen)-2-oxindole;

5-amidino-3-(indol-3-ylmethylen)-2-oxindole;

10 5-hydroxymethyl-3-(indol-3-ylmethylen)-2-oxindole;

3-(5-sulfamoylindol-3-ylmethylen)-2-oxindole;

3-(5-carbomethoxyindol-3-ylmethylen)-2-oxindole;

 $C_{19}H_{14}N_2O_3$  calcd: C 71.69 H 4.43 N 8.80

found: C 71.55 H 4.45 N 8.75

15 MS m/z 318

NMR  $\delta$  ppm (DMSO-d):

3.89 (s, 3H), 6.82 (d, 1H, J=7.5 Hz), 6.95 (ddd, 1H, J=7.5/7.5/1.1 Hz), 7.14 (ddd, 1H, J=7.5/7.5/1.1 Hz), 7.58 (d, 1H, J=8.6 Hz), 7.85 (dd, 1H, J=8.6/1.6 Hz),

20 8.01 (d, 1H, J=7.5 Hz), 8.23 (s, 1H), 8.87 (d, 1H, J=1.6 Hz), 9.51 (s, 1H), 10.53 (bs, 1H), 12.2 (bs, 1H);

3-(5-diethanolamino-3-indolylmethylen)-2-oxindole;

3-[5-(2,3-dihydroxypropylamino)-3-indolylmethylen]-2-oxindole;

25 3-(5-ureido-3-indolylmethylen )-2-oxindole;

3-(5-guanidino-3-indolylmethylen)-2-oxindol ;

3-(5-glyceroylamido-3-indolylmethylen)-2-oxindole;

3-[5-(3-piperidinopropionylamino)-3-indolylmethylen]-2-

-37-

- xindole;
- 3-(5-mesylamino-3-indolylmethylene)-2-oxindole;
- 3-(5-glycoloyloxy-3-indolylmethylene)-2-oxindole;
- 3-[5-(2,3-dihydroxypropoxy)-3-indolylmethylene]-2-
- 5 oxindole;
- 3-(5-aminomethyl-3-indolylmethylene)-2-oxindole;
- 3-(5-amidino-3-indolylmethylene)-2-oxindole;
- 3-(5-hydroxymethyl-3-indolylmethylene)-2-oxindole;
- 5-sulfamoyl-3-(naphth-2-ylmethylene)-2-oxindole;
- 10 5-carbomethoxy-3-(naphth-2-ylmethylene)-2-oxindole;
- 5-diethanolamino-3-(naphth-2-ylmethylene)-2-oxindole;
- 5-(2,3-dihydroxypropylamino)-3-(naphth-2-ylmethylene)-2-
- oxindole;
- 5-ureido-3-(naphth-2-ylmethylene)-2-oxindole;
- 15 5-guanidino-3-(naphth-2-ylmethylene)-2-oxindole;
- 5-glyceroylamido-3-(naphth-2-ylmethylene)-2-oxindole;
- 5-(3-piperidinopropionylamino)-3-(naphth-2-ylmethylene)-
- 2-oxindole;
- 5-mesylamino-3-(naphth-2-ylmethylene)-2-oxindole;
- 20 5-glycoloyloxy-3-(naphth-2-ylmethylene)-2-oxindole;
- 5-(2,3-dihydroxypropoxy)-3-(naphth-2-ylmethylene)-2-
- oxindole;
- 5-aminomethyl-3-(naphth-2-ylmethylene)-2-oxindole;
- 5-amidino-3-(naphth-2-ylmethylene)-2-oxindole;
- 25 5-hydroxymethyl-3-(naphth-2-ylmethylene)-2-oxindol ;
- 5-sulfo-3-(1-hydroxyethyl-2-ylmethylen)-2-oxindole,
- sodium salt;

-38-

$C_{19}H_{16}NO_3SNa$  calcd: C 58.01 H 4.10 N 3.56 S 8.15

Na 5.83

found: C 57.95 H 4.15 N 3.45 S 8.05

Na 5.79

5 MS m/z 393.

NMR  $\delta$  ppm (DMSO):

1.5-1.8 (m, 4H), 2.5-2.9 (m, 4H), 6.66 (d, J=8.0 Hz, 1H),

6.75 (d, J=8.2 Hz, 1H), 7.32 (d, J=8.0 Hz, 1H), 7.44 (dd,

J=8.2 and 1.5 Hz, 1H), 6.69 (s, 1H), 7.89 (d, J=1.5 Hz,

10 1H), 10.6 (bs, 1H).

5-sulfo-3-(4-hydroxytetral-2-ylmethylethylene)-2-oxindol ,  
sodium salt

$C_{19}H_{16}NO_3SNa$  calcd: C 58.01 H 4.10 N 3.56 S 8.15

Na 5.83

15 found: C 57.85 H 4.05 N 3.55 S 8.10

Na 5.69

MS m/z 393.

NMR  $\delta$  ppm (DMSO):

1.6-1.8 (m, 4H), 2.4-2.8 (m, 4H), 6.70 (d, J=8.5 Hz, 1H),

20 6.75 (d, J=7.9 Hz, 1H), 7.29 (d, J=8.5 Hz, 1H), 7.43 (dd,

J=7.9 and 1.5 Hz, 1H), 7.60 (s, 1H), 7.79 (d, J=1.5 Hz,

1H), 10.6 (bs, 1H).

(E,Z)-5-(3-pip ridinopropionylamino)-3-(5-methoxyindol-3-ylmethylethylene)-2-oxindole, hydrochlorid salt

25  $C_{26}H_{29}ClN_4O_3$  calcd: C 64.93 H 6.08 Cl 7.37 N 11.65

C 64.85 H 5.95 Cl 7.25 N 11.58



-39-

MS m/z 481.

NMR  $\delta$  ppm (DMSO):

1.2-2.0 (m, 6H<sub>E</sub>, 6H<sub>Z</sub>), 2.8-3.6 (m, 8H<sub>E</sub>, 8H<sub>Z</sub>), 3.88 (s, 3H<sub>Z</sub>), 3.82 (s, 3H<sub>E</sub>), 6.7-7.0 (m, 2H<sub>E</sub>, 2H<sub>Z</sub>), 7.20 (d, J=2.3 Hz, 1H<sub>E</sub>), 7.20-7.5 (m, 2H<sub>E</sub>, 2H<sub>Z</sub>), 7.57 (d, J=2.3 Hz, 1H<sub>Z</sub>), 7.86 (s, 1H<sub>E</sub>), 7.8° (d, J=1.7 Hz, 1H<sub>Z</sub>), 7.99 (s, 1H<sub>Z</sub>), 8.17 (d, J=3.0 Hz, 1H<sub>E</sub>), 8.31 (d, J=1.7 Hz, 1H<sub>E</sub>), 9.42 (d, J=3.0 Hz, 1H<sub>Z</sub>), 9.8 (bs, 1H<sub>E</sub>, 1H<sub>Z</sub>).

3-[5-(p-chlorophenyl)sulfonylamidoindol-3-yl-methylene]-  
2-oxindole

C<sub>22</sub>H<sub>16</sub>ClN<sub>3</sub>O<sub>3</sub>S calcd: C 61.40 H 3.59 Cl 7.88 S 7.13  
found: C 61.38 H 3.56 Cl 7.55 S 7.05

MS m/z 449.

NMR  $\delta$  ppm (DMSO):

6.82 (m, 2H), 7.00 (m, 1H), 7.15 (m, 1H), 7.36 (d, J=8.6 Hz, 1H), 7.5-7.8 (m, 4H), 7.80 (m, 2H), 7.93 (s, 1H), 9.40 (d, J=2.9 Hz, 1H), 10.0 (bs, 1H), 10.52 (s, 1H), 12.01 (d, J=2.9 Hz, 1H).

5-carboethoxy-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole;

5-carboethoxy-3-(quinol-4-ylmethylene)-2-oxindole;

5-carboethoxy-3-(5-methoxyindol-3-ylmethylene)-2-oxindole;

C<sub>21</sub>H<sub>18</sub>N<sub>2</sub>O<sub>4</sub> calcd: C 69.60 H 5.01 N 7.73  
found: C 69.55 H 4.95 N 7.65

MS m/z 362.

-40-

NMR  $\delta$  ppm (DMSO- $d_6$ ):

- 1.34 (t, 3H, J=7.2 Hz), 3.88 (s, 3H), 4.32 (t, 2H, J=7.2 Hz), 6.85 (dd, 1H, J=8.6 and 2.4 Hz), 6.92 (d, 1H, J=8.4 Hz), 7.39 (d, 1H, J=8.6 Hz), 7.78 (dd, 1H, J=8.4 and 1.5 Hz), 7.83 (d, 1H, J=2.4 Hz), 8.32 (s, 1H), 8.49 (d, 1H, J=1.5 Hz), 9.45 (s, 1H), 10.89 (bs, 1H), 12.0 (bs, 1H);
- 3-(5-carboethoxyindol-3-ylmethylene)-2-oxindole;
- 5-carbobenzyloxy-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole;
- 10 5-carbobenzyloxy-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-carbobenzyloxy-3-(5-methoxyindol-3-ylmethylene)-2-oxindole;
- 3-(5-carbobenzyloxyindol-3-ylmethylene)-2-oxindole;
- 5-phenylcarbamoyl-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole;
- 15 5-phenylcarbamoyl-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-phenylcarbamoyl-3-(5-methoxyindol-3-ylmethylene)-2-oxindole;
- 3-(5-phenylcarbamoylindol-3-ylmethylene)-2-oxindole;
- 20 5-benzylcarbamoyl-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole;
- 5-benzylcarbamoyl-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-benzylcarbamoyl-3-(5-methoxyindol-3-ylmethylene)-2-oxindole;
- 25  $C_{26}H_{21}N_3O_3$  calcd: C 73.74 H 5.00 N 9.92
- found: C 73.71 H 4.99 N 9.85

MS m/z 423.

NMR  $\delta$  ppm (DMSO- $d_6$ ):

-41-

3.86 (s, 3H), 4.51 (d, 2H, J=5.9 Hz), 6.86 (m, 2H),  
 7.1-7.5 (m, 6H), 7.70 (m, 2H), 8.19 (s, 1H),  
 8.38 (d, 1H, J=1.5 Hz), 8.84 (t, 1H, J=5.9 Hz),  
 9.42 (s, 1H), 10.75 (bs, 1H), 12.0 (bs, 1H);

5 3-(5-benzylcarbamoylindol-3-ylmethylene)-2-oxindole;  
 5-carboethoxy-3-(8-hydroxyquinol-5-ylmethylene)-2-oxindole;  
 5-benzylcarbamoyl-3-(8-hydroxyquinol-5-ylmethylene)-2-oxindole; and

10 5-sulfo-3-(5-methoxyindol-3-ylmethylene)-2-oxindole,  
 MS m/z 370

NMR  $\delta$  ppm (DMSO):

3.88 (s, 3H), 6.73 (d, 1H, J=8.1 Hz), 6.81 (dd, 1H,  
 J=8.6 and 2.4 Hz), 7.37 (d, 1H, J=8.6 Hz), 7.43 (dd, 1H,  
 15 J=8.1 and 1.8 Hz), 7.74 (d, 1H, J=2.4 Hz), 8.08 (d, 1H,  
 J=1.8 Hz), 8.14 (s, 1H), 9.43 (s, 1H), 10.51 (bs, 1H),  
 11.8 (bs, 1H);

5-amidino-3-(5-methoxyindol-3-ylmethylene)-2-oxindole  
 hydrochloride,

20 MS m/z 368.

$C_{19}H_{17}ClN_4O_2$  calcd: C 61.87 H 4.65 Cl 9.61 N 15.19

found: C 61.55 H 4.55 Cl 9.55 N 15.01.

### Example 2

5-Sulfo-3-(3-hydroxy-2-phenylacetaldehyde)-2-oxindole

25 A solution of 3-hydroxy-2-phenylacetaldehyde (1.762 g,  
 10 mmol) and 2-oxindol-5-sulfonic acid (2.559 g,

-42-

12 mmol) in anhydrous ethanol (10 ml) was heated to reflux for 1 hour. The reaction mixture was chilled with ice water, the precipitate filtered, the residue washed with ice-cooled ethanol and dried under vacuum. Almost  
 5 pure title compound was obtained in about 70 % yield (2.600 g).

$C_{19}H_{17}NO_5S$  calcd: C 61.44 H 4.61 N 3.77 S 8.63

found: C 61.35 H 4.45 N 3.71 S 8.65

MS m/z 371.

10 IR  $cm^{-1}$ : 3500-2500 (NH, OH), 1690, 1630 (amide), 1600 (arom).

According to the above described procedure and starting from the appropriate compound of formula (II) and formula (III), respectively, one can prepare the following  
 15 compounds as single E- or Z-isomers, as well as their E,Z-mixtures:

5-sulfo-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
 5-sulfo-3-(1-hydroxytetral-2-ylmethylene)-2-oxindole;  
 5-sulfo-3-(4-hydroxytetral-1-ylmethylene)-2-oxindole;  
 20 5-sulfo-3-(quinol-4-ylmethylene)-2-oxindole;  
 5-sulfo-3-(indol-3-ylmethylene)-2-oxindole;  
 3-(5-sulfoindol-3-ylmethylene)-2-oxindole;  
 5-sulfo-3-(naphth-2-ylmethylene)-2-oxindole;  
 5-phosphonooxy-3-(1,4-dihydroxytetral-2-ylmethylene)-2-  
 25 oxindole;  
 5-phosphonooxy-3-(quinol-4-ylmethylene)-2-oxindol ;  
 5-phosphonooxy-3-(indol-3-ylmethylene)-2-oxindole;  
 3-(5-phosphonooxy-3-indolylmethylene)-2-oxindole; and

-43-

5-phosphonooxy-3-(naphth-2-ylmethylene)-2-oxindol .

Example 3

5-(2,3-dihydroxypropylamino)-3-(quinol-4-ylmethylene)-2-oxindole

5 To a stirred solution of 5-amino-3-(quinol-4-ylmethylene)-2-oxindole (2.873 g, 10 mmol) in methanol (30 ml) was added anhydrous methylammonium chloride (0.60 g, 10 mmol). Then sodium cyanoborohydride (0.378 g, 6 mmol) was added in portions. Finally, glyceraldehyde (0.901 g, 10 mmol) was added portionwise over 30 min and the solution stirred at r.t. for 50 h. Ice cold 6N HCl was added until gas evolution (HCN) stopped and the pH of the solution was 2. The methanol was evaporated in vacuo and the remaining aqueous solution was washed with CHCl<sub>3</sub>.  
10 Solid KOH was added until the pH was 12. Solid NaCl was added to saturation and the solution extracted twice with CHCl<sub>3</sub>. The CHCl<sub>3</sub> extracts were washed with saturated NaCl solution, dried over K<sub>2</sub>CO<sub>3</sub> and evaporated. The residue was chromatographed on silica gel using CHCl<sub>3</sub>-MeOH mixtures  
15 as eluant.

Thus pure title compound was obtained in about 60 % yield.

C<sub>21</sub>H<sub>19</sub>N<sub>3</sub>O<sub>3</sub> calcd: C 69.79 H 5.30 N 11.63

found: C 69.75 H 5.25 N 11.55

25 MS m/z 361.

IR cm<sup>-1</sup>: 3500-2500 (NH, OH), 1700, 1640, 1620 (amide),  
1600, 1580 (arom).

-44-

According to the above described procedure, the following compounds can be prepared:

5-(2,3-dihydroxypropylamino)-3-(1,4-dihydroxytetra-2-ylmethylene)-2-oxindole;

5 5-(2,3-dihydroxypropylamino)-3-(indol-3-ylmethylene)-2-oxindole;

3-[5-(2,3-dihydroxypropylamino)-3-indolylmethylene]-2-oxindole;

5-(2,3-dihydroxypropylamino)-3-(naphth-2-ylmethylene)-2-oxindole; and

(E,Z)-5-(2,3-dihydroxypropylamino)-3-(5-methoxy-3-indolylmethylene)-2-oxindole,

MS m/z 379.

NMR  $\delta$  ppm (DMSO):

15 2.7-3.3 (m, 2H<sub>E</sub>+2H<sub>Z</sub>), 3.5-3.8 (m, 1H<sub>E</sub>+1H<sub>Z</sub>), 3.80, 3.86 (2 singlets, 3H<sub>E</sub>+3H<sub>Z</sub>), 4.5-5.2 (bs, 3H<sub>E</sub>+3H<sub>Z</sub>), 6.45 (m, 1H<sub>E</sub>+1H<sub>Z</sub>), 6.58, 6.62 (two d, 1H<sub>E</sub>+1H<sub>Z</sub>, J=6.8 and 6.8 Hz), 6.85 (m, 1H<sub>E</sub>+1H<sub>Z</sub>), 7.13 (d, 1H<sub>E</sub>, J=2.2 Hz), 7.18 (d, 1H<sub>Z</sub>, J=2.2 Hz), 7.23 (d, 1H<sub>E</sub>, J=2.2 Hz), 7.40 (two d, 1H<sub>E</sub>+1H<sub>Z</sub>, J=8.7 and 8.8 Hz), 7.62 (d, 1H<sub>Z</sub>, J=2.6 Hz), 7.76 (s, 1H<sub>E</sub>), 7.94 (s, 1H<sub>Z</sub>), 8.17 (s, 1H<sub>E</sub>), 9.38 (s, 1H<sub>Z</sub>), 10.00, 10.05 (two s, 1H<sub>E</sub>+1H<sub>Z</sub>), 11.7-12.1 (bs, 1H<sub>E</sub>+1H<sub>Z</sub>).

#### Example 4

5-glyceroylamido-3-(quinol-4-ylmethylene)-2-oxindole

25 To a stirred solution of 5-amino-3-(quinol-4-ylmethylene)-2-oxindole (2.873 g, 10 mmol) and glyceric acid

-45-

(1.061 g, 10 mmol) was added dicyclohexylcarbodiimide (2.063 g, 10 mmol). The resulting suspension was stirred for 1 hour at 50-60°C and then for 3 days at room temperature. Then the N,N'-dicyclohexylurea was filtered off, the filtrate evaporated and the residue chromatographed on silica gel using CHCl<sub>3</sub>-MeOH mixtures as eluant. Thus pure title compound was obtained in about 60 % yield.

$C_{21}H_{17}N_3O_4$  calcd: C 67.19 H 4.57 N 11.19  
found: C 67.13 H 4.46 N 11.07

MS m/z 375.

IR cm<sup>-1</sup>: 3500-2500 (NH, OH), 1700, 1680, 1620 (amide)

According to the above described procedure, the following compounds can be prepared:

- 5-glyceroylamido-3-(indol-3-ylmethylene)-2-oxindole;  
3-(5-glyceroylamido-3-indolylmethylene)-2-oxindole; and  
5-glyceroylamido-3-(naphth-3-ylmethylene)-2-oxindole.

#### Example 5

5-mesylamino-3-(quinol-4-ylmethylene)-2-oxindole

- To a stirred solution of 5-amino-3-(quinol-4-ylmethylene)-2-oxindole (2.873 g, 10 mmol) in pyridine (10 ml) was added gradually mesylchloride (1.146 g, 10 mmol) at 0-5°C under cooling. The reaction mixture was stirred for about 5 h at 0-5°C and then for 15 hours at room temperature. The mixture was poured onto an ice-water





-47-

MS m/z 329.

IR cm<sup>-1</sup>: 3500-2500 (NH), 1700 (amide), 1680 (C=NH),  
1620 (amide), 1580 (arom).

According to the above described procedure, the following

5 compounds can be prepared:

5-guanidino-3-(indol-3-ylmethylene)-2-oxindole;  
3-(5-guanidino-3-indolylmethylene)-2-oxindole; and  
5-guanidino-3-(naphth-2-ylmethylene)-2-oxindole.

Example 7

10 5-ureido-3-(quinol-4-ylmethylene)-2-oxindole

To a mixture of 5-amino-3-(quinol-4-ylmethylene)-2-oxindole (2.873 g, 10 mmol) in ice water (20 ml) was added 5N HCl (2 ml, 10 mmol) under stirring. Then the mixture was heated to 70-80°C, sodium cyanate (0.715 g, 15 11 mmol) was added portionwise and the stirring was continued for further 4 h at this temperature. After cooling, the raw product was extracted with CHCl<sub>3</sub>, the organic layer washed to neutrality with saline solution, dried and evaporated in vacuo. The residue was chromatographed on silica gel, using CHCl<sub>3</sub>-MeOH mixtures as  
20 eluant to give pure title compound in about 50 % yield.

C<sub>19</sub>H<sub>14</sub>N<sub>4</sub>O<sub>2</sub> calcd: C 69.08 H 4.27 N 16.96

found: C 69.01 H 4.15 N 16.85

MS m/z 330.

25 IR cm<sup>-1</sup>: 3500-2500 (NH), 1705, 1660, 1640, 1620

-48-

(amide), 1580 (arom).

By proceeding analogously, the following compounds can be prepared:

5-ureido-3-(indol-3-ylmethylene)-2-oxindole;

5 3-(5-ureido-3-indolylmethylene)-2-oxindole; and

5-ureido-3-(naphth-2-ylmethylene)-2-oxindole.

Example 8

5-(2,3-dihydroxypropoxy)-3-(quinol-4-ylmethylene)-2-oxindole

10 To a solution of 5-hydroxy-3-(quinol-4-ylmethylene)-2-oxindole (2.883 g, 10 mmol) in toluene (100 ml) was added portionwise under nitrogen NaH 80 % (0.300 g, 10 mmol). After salification was complete, 3-chloro-1,2-propanediol (1.547 g, 14 mmol) was added and the mixture heated  
15 to reflux for 5 h. After cooling, water was added, the organic phase washed and evaporated to dryness. The residue was submitted to flash chromatography, using CHCl<sub>3</sub>-MeOH mixtures as eluant to give pure title compound in about 70 % yield.

20 C<sub>21</sub>H<sub>18</sub>N<sub>2</sub>O<sub>4</sub> calcd: C 69.60 H 5.01 N 7.73  
found: C 69.55 H 4.95 N 7.65

MS m/z 362.

IR cm<sup>-1</sup>: 3500-2600 (NH, OH), 1700, 1640 (amide), 1600,  
1580 (arom).

25 By proceeding analogously, the following compounds can be prepared:

-49-

5-(2,3-dihydroxypropoxy)-3-(indol-3-ylmethylene)-2-oxindole;

3-[5-(2,3-dihydroxypropoxy)-3-indolylmethylene]-2-oxindole; and

5 5-(2,3-dihydroxypropoxy)-3-(naphth-2-ylmethylene)-2-oxindole.

### Example 9

5-glycoloyloxy-3-(quinol-4-ylmethylene)-2-oxindole

To a stirred solution of 5-hydroxy-3-(quinol-4-ylmethylene)-2-oxindole (2.883 g, 10 mmol) in pyridine (10 ml)  
10 was added gradually glycoloyl chloride (0.945 g, 10 mmol) at 0-5°C under cooling. The reaction mixture was stirred for about 4 h at 0-5°C and then for 15 h at room temperature. The mixture was poured onto an ice-water  
15 mixture, the precipitate filtered off, the residue washed thoroughly with water and then chromatographed on silica gel, using CHCl<sub>3</sub>-MeOH mixtures as eluant. Thus pure title compound was obtained in about 60 % yield.

$C_{20}H_{14}N_2O_4$  calcd: C 69.36 H 4.07 N 8.09

20 found: C 69.31 H 4.01 N 7.95

MS m/z 346.

IR cm<sup>-1</sup>: 3500-2600 (NH, OH), 1740 (ester), 1700, 1640 (amide), 1600, 1580 (arom).

In analogous mann r, the following compounds can be  
25 obtain d:

-50-

5-glycol yloxy-3-(indol-3-ylmethylenes)-2-oxindole;  
3-(5-glycoloyloxy-3-indolylmethylene)-2-oxindole; and  
5-glycoloyloxy-3-(naphth-2-ylmethylenes)-2-oxindole.

Example 10

5 5-phosphonooxy-3-(quinol-4-ylmethylenes)-2-oxindole

A mixture of 5-hydroxy-3-(quinol-4-ylmethylenes)-2-oxindole (2.883 g, 10 mmol) and phosphoric acid 85 % (13 g) and phosphorous pentoxide (10 g) was heated for 2 h at 60°C. The usual work-up gave the title compound in  
10 about 50 % yield.

$C_{18}H_{13}N_2O_5P$  calcd: C 58.71 H 3.56 N 7.61 P 8.41

found: C 58.65 H 3.51 N 7.45 P 8.35

MS m/z 368.

IR  $cm^{-1}$ : 3500-2500 (OH), 1700, 1640, 1620 (amide),  
15 1600, 1580 (arom).

According to the above described procedure, the following compounds can be obtained:

5-phosphonooxy-3-(indol-3-ylmethylenes)-2-oxindole;  
3-(5-phosphonooxy-3-indolylmethylene)-2-oxindole; and  
20 5-phosphonooxy-3-(naphth-2-ylmethylenes)-2-oxindole.

Example 11

5-carb methoxy-3-(quinol-4-ylmethylenes)-2-oxindole

A solution f 5-carboxy-3-(quinol-4-ylm thylenes)-2-

-51-

oxindol (3.163 g, 10 mmol), methanol (3.2 g, 100 mmol) and  $H_2SO_4$  95 % (1 g) in benzene (100 ml) was heated in a Soxhlet apparatus for 10 h. To dry the distillate continuously, the cap of the Soxhlet contained anhydrous  $MgSO_4$ . After cooling, water was added, the organic phase repeatedly washed with water and then evaporated under vacuum. Thus almost pure title compound was obtained in about 90 % yield.

$C_{20}H_{14}N_2O_3$  calcd: C 72.72 H 4.27 N 8.48  
found: C 72.65 H 4.23 N 8.35

MS m/z 330.

IR  $cm^{-1}$ : 3500-2500 (NH), 1720 (ester), 1700, 1640 (amide), 1600, 1580 (arom).

By proceeding analogously, the following compounds can be obtained:

5-carbomethoxy-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-carbomethoxy-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole;  
5-carbomethoxy-3-(indol-3-ylmethylene)-2-oxindole;  
3-(5-carbomethoxyindol-3-ylmethylene)-2-oxindole; and  
5-carbomethoxy-3-(naphth-2-ylmethylene)-2-oxindole.

#### Example 12

5-amidino-3-(quinol-4-ylmethylene)-2-oxindole, hydrochloride salt

To a solution of 5-cyano-3-(quinol-4-ylmethylene)-2-

-52-

oxindole (2.973 g, 10 mmol) in anhydrous diethyl ether (100 ml), a stoichiometric amount of ethanol (0.460 g, 10 mmol) was added and the solution was saturated with HCl gas. The solution was kept overnight in the fridge in order to precipitate the iminoether hydrochloride salt. The precipitated iminoether hydrochloride was dissolved in ethanol (50 ml) to which was added an anhydrous alcoholic ammonia solution. Thereupon, the solution was kept several days at room temperature and the precipitated little amount of  $\text{NH}_4\text{Cl}$  was filtered off. The solution was evaporated in vacuum, thus obtaining almost pure title compound.

$\text{C}_{19}\text{H}_{14}\text{N}_4\text{O} \cdot \text{HCl}$  calcd: C 65.05 H 4.31 N 15.97 Cl 10.11

found: C 65.01 H 4.25 N 15.85 Cl 10.05

MS m/z 350.

The following compounds can be obtained following the above described method:

5-amidino-3-(indol-3-ylmethylene)-2-oxindole hydrochloride;

5-amidino-3-(5-methoxyindol-3-ylmethylene)-2-oxindole hydrochloride;

3-(5-amidino-3-indolylmethylene)-2-oxindole hydrochloride; and

5-amidino-3-(naphth-2-ylmethylene)-2-oxindole hydrochloride.

#### Example 13

5-aminomethyl-3-(quinol-4-ylmethylene)-2-oxindole

-53-

To a solution of 5-chloromethyl-3-(quinol-4-ylmethylene)-  
2-oxindole (3.208 g, 10 mmol) in  $\text{CHCl}_3$  (50 ml) was added  
a solution of hexamethylenetetramine (1.402 g, 10 mmol)  
in  $\text{CHCl}_3$  (20 ml) at 40-50°C. The resulting quaternary  
5 salt was filtered off after cooling. The crystalline  
residue was then dissolved in a mixture of ethanol  
(5.5 g, 120 mmol) and  $\text{HCl}$  32 % (3 ml, 30 mmol) and the  
diethoxymethane formed was eliminated by distillation.  
The latter operation was repeated twice. After  
10 alkalization with diluted soda solution, the raw  
product was extracted with  $\text{CHCl}_3$ , the organic layer  
washed to neutrality, dried and evaporated. The residue  
was submitted to column chromatography on silica gel,  
using a  $\text{CHCl}_3$ -EtOH mixture as eluant, thus giving pure  
15 title compound in 65 % yield.

$\text{C}_{19}\text{H}_{15}\text{N}_3\text{O}$  calcd: C 75.73 H 5.02 N 13.94

found: C 75.65 H 4.95 N 13.89

MS  $m/z$  301.

IR  $\text{cm}^{-1}$ : 3500-2600 (NH), 1695, 1640, 1620 (amide), 1580

20 (arom).

The following compounds are obtained by proceeding  
analogously:

5-aminomethyl-3-(indol-3-ylmethylene)-2-oxindole;

3-(5-aminomethyl-3-indolylmethylene)-2-oxindole; and

25 5-aminomethyl-3-(naphth-2-ylmethylene)-2-oxindol .

#### Example 14

5-sulfo-3-(3-hydroxytetrahydro-2-ylmethylene)-2-oxindol ,

-54-

sodium salt

To a solution of 5-sulfo-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole (3.714 g, 10 mmol) in 1N NaOH (10 ml, 10 mmol) was added isopropanol (30 ml) and the

5 ~~mixture was chilled under stirring to 0-5°C. The~~  
precipitated sodium salt was filtered, washed with ice-cooled isopropanol and dried under vacuum.

$C_{19}H_{16}NO_3SNa$  calcd: C 58.01 H 4.10 N 3.56 S 8.15

Na 5.85

10 found: C 57.95 H 4.05 N 3.45 S 8.20

Na 5.75

MS m/z 393.

The following salt can be obtained in an analogous manner:

15 5-sulfo-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole,  
sodium salt;

5-sulfo-3-(quinol-4-ylmethylene)-2-oxindole, sodium salt;

5-sulfo-3-(indol-3-ylmethylene)-2-oxindole, sodium salt;

3-(5-sulfoindol-3-ylmethylene)-2-oxindole, sodium salt;

20 5-sulfo-3-(naphth-2-ylmethylene)-2-oxindole, sodium salt;

5-sulfo-3-(1-hydroxytetral-2-ylmethylene)-2-oxindole,  
sodium salt.

$C_{19}H_{16}NO_3SNa$  calcd: C 58.01 H 4.10 N 3.56 S 8.15

Na 5.83

25 found: C 57.95 H 4.15 N 3.45 S 8.05

Na 5.79

MS m/z 393.

NMR  $\delta$  ppm (DMSO):



-55-

1.5-1.8 (m, 4H), 2.5-2.9 (m, 4H), 6.66 (d, J=8.0 Hz, 1H),  
6.75 (d, J=8.2 Hz, 1H), 7.32 (d, J=8.0 Hz, 1H), 7.44 (dd,  
J=8.2 and 1.5 Hz, 1H), 6.69 (s, 1H), 7.89 (d, J=1.5 Hz,  
1H), 10.6 (bs, 1H).

5 5-sulfo-3-(4-hydroxytetral-2-ylmethylene)-2-oxindole,  
sodium salt;

$C_{19}H_{16}NO_3SNa$  calcd: C 58.01 H 4.10 N 3.56 S 8.15

Na 5.83

found: C 57.85 H 4.05 N 3.55 S 8.10

10 Na 5.69

MS m/z 393.

NMR  $\delta$  ppm (DMSO):

1.6-1.8 (m, 4H), 2.4-2.8 (m, 4H), 6.70 (d, J=8.5 Hz, 1H),  
6.75 (d, J=7.9 Hz, 1H), 7.29 (d, J=8.5 Hz, 1H), 7.43 (dd,  
15 J=7.9 and 1.5 Hz, 1H), 7.60 (s, 1H), 7.79 (d, J=1.5 Hz,  
1H), 10.6 (bs, 1H).

#### Example 15

5-aminomethyl-3-(quinol-4-ylmethylene)-2-oxindole, hydro-  
chloride salt

20 To a solution of 5-aminomethyl-3-(quinol-4-ylmethylene)-  
2-oxindole (3.014 g, 10 mmol) in ethanol (10 ml) was  
added 1N hydrochloric acid (2 ml, 2 mmol) and the  
resulting mixture was vaporat d t dryness und r vacuum,  
thus giving pure title compound in about 100 % yield.

25  $C_{19}H_{17}N_2OCl_2$  calcd: C 60.97 H 4.58 N 11.23 Cl 18.95

-56-

found: C 60.85 H 4.45 N 11.15 Cl 18.90

MS m/x 374.

Example 16

Tablets each weighing 0.150 g and containing 25 mg of the

5 active substance, can be manufactured as follows:

Composition (for 10,000 tablets):

5-sulfo-3-(3-hydroxytetral-2-

ylmethylene)-2-oxindole 250 g

Lactose 800 g

10 Corn starch 415 g

Talc powder 30 g

Magnesium stearate 5 g

The 5-sulfo-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole,  
the lactose and half the corn starch are mixed; the  
15 mixture is then forced through a sieve of 0.5 mm mesh  
size.

Corn starch (10 g) is suspended in warm water (90 ml) and  
the resulting paste is used to granulate the powder. The  
granulate is dried, comminuted on a sieve of 1.4 mm mesh  
20 size, then the remaining quantity of starch, talc and  
magnesium stearate is added, carefully mixed and  
processed into tablets.

-57-

Example 17

Capsules, each dosed at 0.200 g and containing 20 mg of the active substance can be prepared.

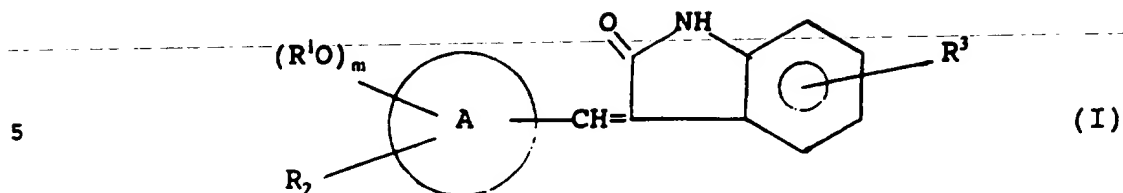
Composition for 500 capsules:

- 
- |    |  |      |
|----|--|------|
| 5  | 5-sulfamoyl-3-(3-hydroxytetral-2-ylmethylene)-   |      |
|    | 2-oxindole   | 10 g |
|    | Lactose  | 80 g |
|    | Corn starch  | 5 g  |
|    | Magnesium stearate   | 5 g  |
| 10 | This formulation is encapsulated in two-piece hard gelatin capsules and dosed at 0.200 g for each capsule. |      |

-58-

CLAIMS

1. A compound of formula (I)



wherein

m is zero, 1 or 2;

A is a bicyclic ring chosen from tetralin,  
 10 naphthalene, quinoline and indole;

R¹ is hydrogen, C₁-C₆ alkyl or C₂-C₆ alkanoyl;

one of R² and R³ independently is hydrogen and the  
 other is a substituent selected from:

a C₁-C₆ alkyl group substituted by 1, 2 or 3 hydroxy  
 15 groups;

-SO₃R⁴ in which R⁴ is hydrogen or C₁-C₆ alkyl  
 unsubstituted or substituted by 1, 2 or 3 hydroxy  
 groups;

-SO₂NHR⁵ in which R⁵ is as R⁴ defined above or a  
 20 -(CH₂)ₙ-N(C₁-C₆ alkyl)₂ group in which n is 2 or 3;

-COOR⁶ in which R⁶ is C₁-C₆ alkyl unsubstituted or  
 substituted by ph nyl or by 1, 2 or 3 hydroxy groups  
 r phenyl;

-CONHR⁷ in which R⁷ is hydrogen, ph nyl or C₁-C₆ alkyl  
 25 substitut d by 1, 2 or 3 hydroxy groups or by

-59-





phenyl;

$-\text{NHSO}_2\text{R}^8$  in which  $\text{R}^8$  is  $\text{C}_1\text{-C}_6$  alkyl or phenyl unsubstituted or substituted by halogen or by  $\text{C}_1\text{-C}_4$  alkyl;

5  $-\text{N}(\text{R}^9)_2$ ,  $-\text{NHR}^9$  or  $-\text{OR}^9$  wherein  $\text{R}^9$  is  $\text{C}_1\text{-C}_6$  alkyl substituted by 1, 2 or 3 hydroxy groups;

$-\text{NHCOR}^{10}$ ,  $-\text{OOCR}^{10}$  or  $-\text{CH}_2\text{OOCR}^{10}$  in which  $\text{R}^{10}$  is  $\text{C}_1\text{-C}_6$  alkyl substituted by 1, 2 or 3 hydroxy groups;

$-\text{NHCONH}_2$ ;  $-\text{NH}-\text{C}(\text{NH}_2)=\text{NH}$ ;  $-\text{C}(\text{NH}_2)=\text{NH}$ ;  $-\text{CH}_2\text{NHC}(\text{NH}_2)=\text{NH}$ ;

10  $-\text{CH}_2\text{NH}_2$ ;  $-\text{OPO}(\text{OH})_2$ ;  $-\text{CH}_2\text{OPO}(\text{OH})_2$ ;  $-\text{PO}(\text{OH})_2$ ; or a  
 $-\text{CH}_2-\text{N}$   Z,  $-\text{SO}_2-\text{N}$   Z,  $-\text{CON}$   Z or  $-\text{NHCO}(\text{CH}_2)_p-\text{N}$   Z  
 group,


wherein p is 1, 2 or 3 and Z is  $-\text{CH}_2-$ ,  $-\text{O}-$  or  $>\text{N}-\text{R}^{11}$   
 in which  $\text{R}^{11}$  is hydrogen or is as  $\text{R}^9$  defined above;  
 15 and the pharmaceutically acceptable salts thereof.

2. A compound of formula (I) according to claim 1,  
 wherein

A and m are as defined in claim 1;

$\text{R}^1$  is hydrogen or  $\text{C}_1\text{-C}_4$  alkyl;

20 one of  $\text{R}^2$  and  $\text{R}^3$  independently is hydrogen and the  
 other is a substituent selected from  $-\text{SO}_3\text{H}$ ;  $-\text{SO}_2\text{NH}_2$ ;  
 $\text{COOR}^6$  wherein  $\text{R}^6$  is  $\text{C}_1\text{-C}_4$  alkyl or benzyl,  $-\text{CONHR}^7$   
 wherein  $\text{R}^7$  is phenyl or benzyl;  $-\text{N}(\text{CH}_2\text{CH}_2\text{OH})_2$ ;

25  $-\text{NHCH}_2\text{CHOHCH}_2\text{OH}$ ;  $-\text{NHCONH}_2$ ;  $-\text{NHC}(\text{NH}_2)=\text{NH}$ ;  
 $-\text{NHCOCHOHCH}_2\text{OH}$ ;  $-\text{NHCOCH}_2\text{CH}_2-\text{N}$   ;  $-\text{NHSO}_2\text{C}_1\text{-C}_4$  alkyl;  
 $-\text{OCH}_2\text{CHOHCH}_2\text{OH}$ ;  $-\text{OOCCH}_2\text{OH}$ ;  $-\text{CH}_2\text{NH}_2$ ;  $-\text{CH}_2\text{OH}$ ;  $-\text{C}(\text{NH}_2)=\text{NH}$   
 and  $-\text{OPO}(\text{OH})_2$ ; and the pharmaceutically acceptable

-60-

salts thereof.

3. A compound selected from the group consisting of the following compounds, which, when appropriate, may be either Z- or E-diastereomers or Z,E-mixtures of said

5 diastereomers:

5-sulfo-3-[1,4-dihydroxytetral-2-ylmethylene]-2-oxindole;

5-sulfamoyl-3-[1,4-dihydroxytetral-2-ylmethylene]-2-oxindole;

10 5-sulfo-3-[1-hydroxytetral-2-ylmethylene]-2-oxindole;

5-sulfamoyl-3-[1-hydroxytetral-2-ylmethylene]-2-oxindole;

15 5-sulfo-3-[3-hydroxytetral-2-ylmethylene]-2-oxindole;

5-sulfamoyl-3-[3-hydroxytetral-2-ylmethylene]-2-oxindole;

5-sulfo-3-[4-hydroxytetral-1-ylmethylene]-2-oxindole;

20 5-sulfamoyl-3-[4-hydroxytetral-1-ylmethylene]-2-oxindole;

5-carbomethoxy-3-[1,4-dihydroxytetral-2-ylmethylene]-2-oxindole;

25 5-carbomethoxy-3-[3-hydroxytetral-2-ylmethylene]-2-oxindole;

5-diethanolamino-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;

-61-

- 5-(2,3-dihydroxypropylamino)-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-ureido-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-guanidino-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-glyceroylamido-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-(3-piperidinopropionylamino)-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-mesylamino-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-glycoloyloxy-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-(2,3-dihydroxypropoxy)-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-aminomethyl-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-amidino-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-hydroxymethyl-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-phosphonoxy-3-(1,4-dihydroxytetral-2-ylmethylene)-2-oxindole;  
5-sulfo-3-(quinol-4-ylmethyl)-2-oxindole;  
5-sulfamoyl-3-(quinol-4-ylmethylene)-2-oxindole;  
5-carbomethoxy-3-(quinol-4-ylmethylene)-2-oxindole;  
5-diethanolamino-3-(quinol-4-ylmethyl)-2-

-62-

- oxindole;
- 5-(2,3-dihydroxypropylamino)-3-(quinol-4-yl  
methylene)-2-oxindole;
- 5-ureido-3-(quinol-4-ylmethylene)-2-oxindole;
- 5 5-guanidino-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-glyceroylamido-3-(quinol-4-ylmethylene)-2-  
oxindole;
- 5-(3-piperidinopropionylamino)-3-(quinol-4-yl  
methylene)-2-oxindole;
- 10 5-mesylamino-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-glycoloyloxy-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-(2,3-dihydroxypropoxy)-3-(quinol-4-ylmethylene)-2-  
oxindole;
- 5-aminomethyl-3-(quinol-4-ylmethylene)-2-oxindole;
- 15 5-amidino-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-hydroxymethyl-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-phosphonooxy-3-(quinol-4-ylmethylene)-2-oxindol ;
- 5-sulfo-3-(indol-3-ylmethylene)-2-oxindole;
- 5-sulfamoyl-3-(indol-3-ylmethylene)-2-oxindole;
- 20 5-carbomethoxy-3-(indol-3-ylmethylene)-2-oxindole;
- 5-diethanolamino-3-(indol-3-ylmethylene)-2-oxindole;
- 5-(2,3-dihydroxypropylamino)-3-(indol-3-yl  
methylene)-2-oxindole;
- 5-ureido-3-(indol-3-ylmethylene)-2-oxindole;
- 25 5-guanidino-3-(indol-3-ylmethylen )-2-oxindole;
- 5-glyceroylamid -3-(indol-3-ylmethylene)-2-oxindole;
- 5-(3-piperidinopropionylamino)-3-(indol-3-yl  
ethylene)-2-oxindole;



-63-

- 5-mesylamino-3-(indol-3-ylmethylene)-2-oxindole;  
 5-glycoloyloxy-3-(indol-3-ylmethylen)-2-oxindole;  
 5-(2,3-dihydroxypropoxy)-3-(indol-3-ylmethylen)-2-oxindole;  
 5-aminomethyl-3-(indol-3-ylmethylen)-2-oxindole;  
 5-amidino-3-(indol-3-ylmethylen)-2-oxindole;  
 5-hydroxymethyl-3-(indol-3-ylmethylen)-2-oxindole;  
 5-phosphonooxy-3-(indol-3-ylmethylen)-2-oxindole;  
 3-(5-sulfoindol-3-ylmethylen)-2-oxindole;  
 3-(5-sulfamoylindol-3-ylmethylen)-2-oxindole;  
 3-(5-carbomethoxyindol-3-ylmethylen)-2-oxindole;  
 3-(5-diethanolamino-3-indolylmethylen)-2-oxindole;  
 3-[5-(2,3-dihydroxypropylamino)-3-indolylmethylen]-2-oxindole;  
 3-(5-ureido-3-indolylmethylen)-2-oxindole;  
 3-(5-guanidino-3-indolylmethylen)-2-oxindole;  
 3-(5-glyceroylamido-3-indolylmethylen)-2-oxindole;  
 3-[5-(3-piperidinopropionylamino)-3-indolylmethylen]-2-oxindole;  
 3-(5-mesylamino-3-indolylmethylen)-2-oxindole;  
 3-(5-glycoloyloxy-3-indolylmethylen)-2-oxindole;  
 3-[5-(2,3-dihydroxypropoxy)-3-indolylmethylen]-2-oxindole;  
 3-(5-aminomethyl-3-indolylmethylen)-2-oxindole;  
 3-(5-amidino-3-indolylmethylene)-2-oxindole;  
 3-(5-hydroxymethyl-3-indolylmethylene)-2-oxindole;  
 3-(5-phosphonooxy-3-indolylmethylen)-2-oxindole;  
 5-sulfo-3-(naphth-2-ylmethylen)-2-oxindole;

-64-

- 5-sulfamoyl-3-(naphth-2-ylmethylene)-2-oxindole;  
5-carbomethoxy-3-(naphth-2-ylmethylene)-2-oxindole;  
5-diethanolamino-3-(naphth-2-ylmethylene)-2-oxindole;
- 5 5-(2,3-dihydroxypropylamino)-3-(naphth-2-ylmethylene)-2-oxindole;
- 5-ureido-3-(naphth-2-ylmethylene)-2-oxindole;  
5-guanidino-3-(naphth-2-ylmethylene)-2-oxindole;  
5-glyceroylamido-3-(naphth-2-ylmethylene)-2-oxindole;
- 10 5-(3-piperidinopropionylamino)-3-(naphth-2-ylmethylene)-2-oxindole;  
5-mesylamino-3-(naphth-2-ylmethylene)-2-oxindole;  
5-glycoloyloxy-3-(naphth-2-ylmethylene)-2-oxindole;
- 15 5-(2,3-dihydroxypropoxy)-3-(naphth-2-ylmethylene)-2-oxindole;  
5-aminomethyl-3-(naphth-2-ylmethylene)-2-oxindole;  
5-amidino-3-(naphth-2-ylmethylene)-2-oxindole;  
5-hydroxymethyl-3-(naphth-2-ylmethylene)-2-oxindole;
- 20 5-phosphonooxy-3-(naphth-2-ylmethylene)-2-oxindole;  
5-sulfo-3-(1-hydroxytetral-2-ylmethylene)-2-oxindole;  
5-sulfo-3-(4-hydroxytetral-2-ylmethylene)-2-oxindole;
- 25 5-(3-piperidinopropionylamino)-3-(5-methoxyindol-3-ylmethylene)-2-oxindol ;  
3-[5-(p-chlorophenyl)sulfonylamidoindol-3-ylmethylene]-2-oxindole;

-65-

- 5-carboethoxy-3-(3-hydroxytetral-2-ylmethyl)en)-2-oxindole;
- 5-carboethoxy-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-carboethoxy-3-(5-methoxyindol-3-ylmethylene)-2-oxindole;
- 3-(5-carboethoxyindol-3-ylmethylene)-2-oxindole;
- 5-carbobenzyloxy-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole;
- 5-carbobenzyloxy-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-carbobenzyloxy-3-(5-methoxyindol-3-ylmethylene)-2-oxindole;
- 3-(5-carbobenzyloxyindol-3-ylmethylene)-2-oxindole;
- 5-phenylcarbamoyl-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole;
- 5-phenylcarbamoyl-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-phenylcarbamoyl-3-(5-methoxyindol-3-ylmethylene)-2-oxindole;
- 3-(5-phenylcarbamoylindol-3-ylmethylene)-2-oxindole;
- 5-benzylcarbamoyl-3-(3-hydroxytetral-2-ylmethylene)-2-oxindole;
- 5-benzylcarbamoyl-3-(quinol-4-ylmethylene)-2-oxindole;
- 5-benzylcarbamoyl-3-(5-methoxyindol-3-ylmethylene)-2-oxindole;
- 3-(5-benzylcarbamoylindol-3-ylmethylene)-2-oxindole;
- 5-carboethoxy-3-(8-hydroxyquinol-5-ylmethylene)-2-

-66-

oxindole;

5-benzylcarbamoyl-3-(8-hydroxyquinol-5-ylmethylene)-  
2-oxindole;

5-sulfo-3-(5-methoxyindol-3-ylmethylene)-2-oxindol ;

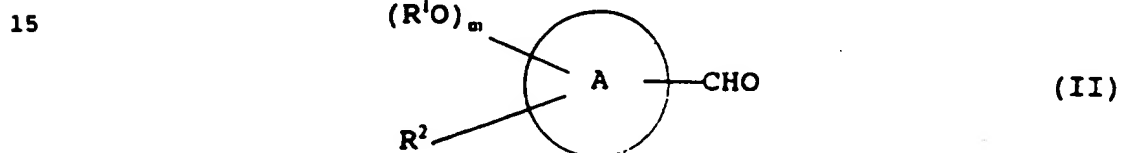
5-(2,3-dihydroxypropylamino)-3-(5-methoxy-3-indolyl-  
methylmethylene)-2-oxindole;

5-amidino-3-(5-methoxyindol-3-ylmethylene)-2-  
-oxindole;

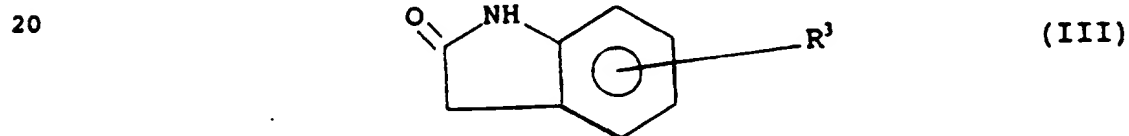
and the pharmaceutically acceptable salts thereof.

- 10 4. A process for the preparation of a compound of  
formula (I), or a pharmaceutically acceptable salt  
thereof, according to claim 1, the process  
comprising:

a) condensation of an aldehyde of formula (II)



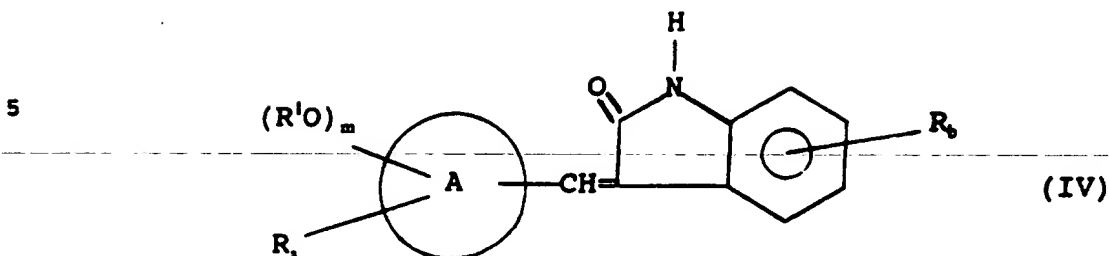
wherein A, R<sup>1</sup>, R<sup>2</sup> and m are as defined in claim 1,  
with a compound of formula (III)



wherein R<sup>3</sup> is as defined in claim 1; r


-67-

b) N-alkylation of a compound of formula (IV)



wherein  $R^1$ ,  $A$  and  $m$  are as defined in claim 1, and one of  $R_1$  and  $R_2$  is  $-NH_2$  and the other is hydrogen, thus obtaining a compound of formula (I) wherein one of  $R^2$  and  $R^3$  is a group  $-NHR^9$  or  $-N(R^9)_2$  in which  $R^9$  is as defined in claim 1 and the other is hydrogen; or

10

c) N-acylating a compound of formula (IV), as defined above, thus obtaining a compound of formula (I) wherein one of  $R^2$  and  $R^3$  is a  $-NHCOR^{10}$  or  $-NHCO(CH_2)_p-N$    $Z$  group, in which  $R^{10}$ ,  $p$  and  $Z$  are as defined in claim 1 and the other is hydrogen; or

15

d) N-sulfonylation of a compound of formula (IV), as defined above, thus obtaining a compound of formula (I), wherein one of  $R^2$  and  $R^3$  is hydrogen and the other is  $-NHSO_2R^4$  in which  $R^4$  is as defined in claim 1; or

20

e) N-amidination of a compound of formula (IV), as defined above, thus obtaining a compound of formula

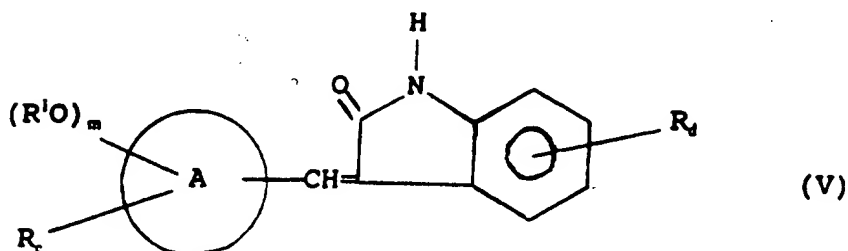
-68-

(I), wherein one of  $R^2$  and  $R^3$  is hydrogen and the other is  $-NHC(NH_2)=NH$ ; or

f) N-carbamoylation of a compound of formula (IV),  
 as defined above, thus obtaining a compound of  
 formula (I), wherein one of  $R^2$  and  $R^3$  is hydrogen and  
 the other is  $-NHCONH_2$ ; or

g) O-alkylation of a compound of formula (V)

10



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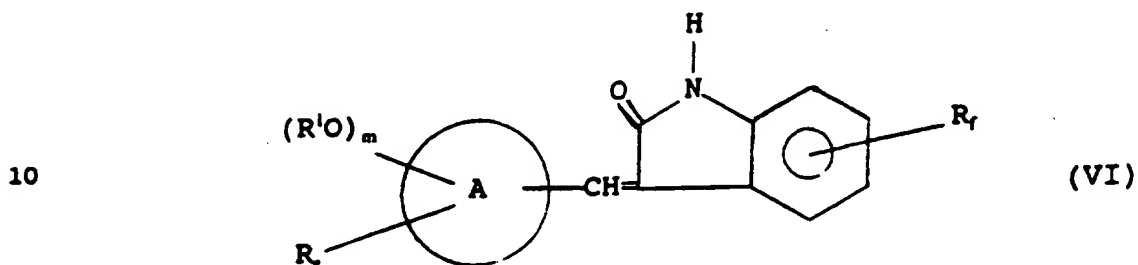
wherein  $R^1$ , m and A are as defined in claim 1, on  
 of  $R_c$  and  $R_d$  is  $-OH$  and the other is hydrogen, thus  
 obtaining a compound of formula (I) wherein one of  
 $R^2$  and  $R^3$  is a group  $-OR^9$  in which  $R^9$  is as defined in  
 claim 1 and the other is hydrogen; or

20

h) O-acylating of a compound of formula (V), as  
 defined above, thus obtaining a compound of formula  
 (I) wherein one of  $R^2$  and  $R^3$  is hydrogen and the  
 other is a group  $-OOCR^{10}$  in which  $R^{10}$  is as defined in  
 claim 1; or

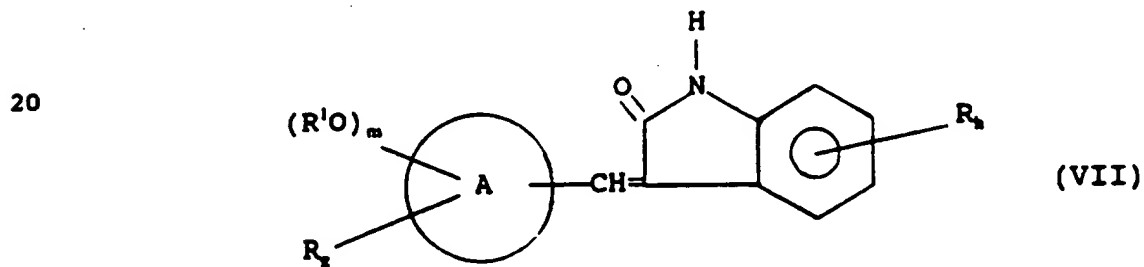
i) O-phosphorylation of a compound of formula (V), as defined above, thus obtaining a compound of formula (I), wherein one of  $R^2$  and  $R^3$  is hydrogen and the other is  $-OPO(OH)_2$ ; or

5 k) esterification of a compound of formula (VI)



wherein  $R^1$ ,  $m$  and  $A$  are as defined in claim 1 and one of  $R_5$  and  $R_7$  is  $-COOH$  and the other is hydrogen, thus obtaining a compound of formula (I), wherein  
 15 one of  $R^2$  and  $R^3$  is hydrogen and the other is  $-COOR^6$  in which  $R^6$  is as defined in claim 1; or

l) ammonia addition to a compound of formula (VII)

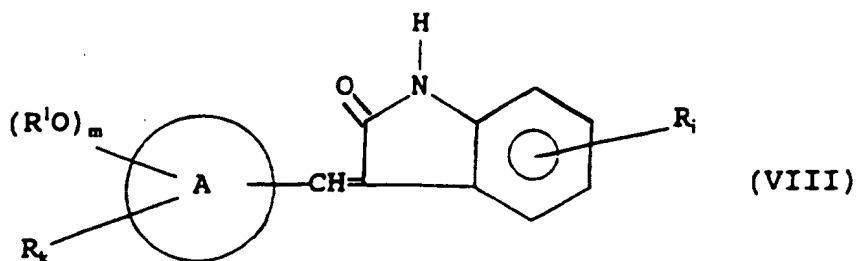



wherein  $R^1$ ,  $A$  and  $m$  are as defined in claim 1 and one of  $R_5$  and  $R_8$  is  $-CN$  and the other is hydrogen, thus obtaining a compound of formula (I), wherein  
 25

-70-

one of  $R^2$  and  $R^3$  is hydrogen and the other is  $-C(NH_2)=NH$ ; or

m) amination of a compound of formula (VIII)



10 wherein  $R^1$ ,  $m$  and  $A$  are as defined in claim 1 and one of  $R_4$  and  $R_5$  is  $-CH_2Cl$  and the other is hydrogen, thus obtaining a compound of formula (I), wherein one of  $R^2$  and  $R^3$  is hydrogen and the other is a  $-CH_2NH_2$  or  $-CH_2-N$    $Z$  group in which  $Z$  is as defined

15 in claim 1; and, if desired, the conversion of a compound of formula (I) into another compound of formula (I), and/or, if desired, the conversion of a compound of formula (I) into a salt thereof, and/or, if desired, converting a salt of a compound

20 of formula (I) into a free compound of formula (I), and/or, if desired, separating a mixture of isomers of a compound of formula (I) into the single isomers.



-71-

5. A pharmaceutical composition containing a suitable carrier and/or diluent and, as an active principle, a compound of formula (I) according to claim 1 or a pharmaceutically acceptable salt thereof.
- 
- 5 6. A compound of formula (I) according to claim 1, or a pharmaceutically acceptable salt thereof, for use as a tyrosine kinase inhibitor.
7. A compound of formula (I) according to claim 1, or a pharmaceutically acceptable salt thereof, for use  
10 as an antiproliferative agent.
8. A compound of formula (I) according to claim 1, or a pharmaceutically acceptable salt thereof, for use as an anti-tumor agent.
9. A compound of formula (I) according to claim 1, or  
15 a pharmaceutically acceptable salt thereof, for use in the control of angiogenesis, as anti-metastatic agent, in treating diabetic complications, in the treatment of epidermal hyperproliferation, in inhibiting the development of the atheromatous  
20 plaqu and rest nosis.

-72-

10. Products containing a compound of formula (I) as  
defined in claim 1, or a pharmaceutically acceptable  
salt thereof, and an additional anti-tumor agent as  
a combined preparation for simultaneous, separate or  
5 sequential use in anti-cancer therapy.

# INTERNATIONAL SEARCH REPORT

Inter. nat. Application No.  
PCT/EP 95/05176

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 C07D209/34 C07D401/06 A61K31/40

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages             | Relevant to claim No. |
|------------|--|-----------------------|
| X          | WO,A,95 01349 (FARMITALIA ERBA CARLO SPA)<br>12 January 1995<br>see the whole document<br>---  | 1-10                  |
| X          | EP,A,0 525 472 (FARMITALIA ERBA CARLO SPA)<br>3 February 1993<br>see the whole document<br>--- | 1-10                  |
| P,X        | WO,A,95 17181 (PHARMACIA SPA) 29 June 1995<br>see the whole document<br>-----                  | 1-10                  |

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

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- \*E\* earlier document but published on or after the international filing date
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- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search

26 March 1996

Date of mailing of the international search report

10.04.96

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